THE

ELECTRICAL REVIEW.

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THE B.A. MECHANICAL SECTION.

PRESIDENTIAL addresses generally have of late years changed somewhat in character. There was a time when, especially if the address was that given to the Association as a body, and not simply to one of the sections, the President seemed to consider it incumbent upon him to say something startling, and on at least one occasion this tendency to self-glorification, which really underlaid the effusion, developed into an aggressive and dogmatic irreverence, and an excursion into the domain of shallow speculation entirely foreign to the spirit of the Association and to sober scientific fact.

It is to such an extent, therefore, not a little refreshing to read the address to the Mechanical Science Section by Prof. Kennedy. By the way, how long does it take to purge a man of his antecedents. We all speak of *Professor* Kennedy, and in the address under review he speaks of himself as having been five years free of this title, which does not, we think, sit well on a practising engineer.

The subject matter of the address was the critical side of mechanical training, by which we are to understand that kind of training which should have for its aim the cultivation of the faculty for appreciation of the fitness of things, as an American would say, or of proportionate values which, perhaps narrowly, in brief, to use an expression of commercial engineering, is to know when a thing is "good enough." The professorial instinct is very strong yet in the Mechanical Section President, and it may be that he over-values mere scholastic training as a means of preparation for the engineering profession.

Now, it seems to us that the view of training as a means to success, in the ordinary acceptation of the word, is wrong. No amount of scientific training can give the commercial instinct. True it makes a man better—more enjoyable as a fellow creature—but it does not make him rich, and is very apt to confer on him a disposition of a modest and retiring nature, so as to unfit him even in the very attempt to secure such a position as his scientific training fits him for, as against a more assertive and voluble competitor.

We are, however, quite at one with the opinion that too little attention is given to the literary training of the engineer, whereby he may be enabled to make himself understood, not simply in words but on paper. Only those actually engaged in business can be aware of the difficulty in corresponding with very many men. The literary ability must not merely include the power of making himsel understood, of saying clearly what he means, and just what he means, but it must include the power to grasp the meaning of almost illiterate correspondents, and of correspondent who are, perhaps, simply ignorant of mechanical subjects, and such men are to be found in plenty, not merely in the ranks of the laymen, but amongst engineers who can write

the four mystic letters to their names; men who have, it may be, advanced in the ranks by the agency of Time's scythe and keep their posts by inertia, by the good will of their superiors, the brains of friendly subordinates, and the precious few demands that are made in large established concerns for other than mere routine duties.

Speaking of the sense of proportion, the Professor says we have all met with cases of certain methods stigmatised as wholly wrong, because they contain provable errors, and of other cases which the most dogmatic condemnation has attended where the value of the errors is not one-tenth so great as the unavoidable errors of the more theoretically perfect method.

It is, perhaps, to the appreciation of proportion that Americans owe so much of their success in mechanics. They are apt to use very incorrect mechanical movements and methods of construction that work with perfect satisfaction. An instance of this is seen in nearly all their locomotives, the valve spindle of which is connected by a rigid unjointed rod to a lever, which moves in an arc, and ought to cause leakage at the gland. Practice shows that the error due to the arc is sufficiently eliminated by the length and limberness of the rod.

How far mere conceit and self-opinionativeness will blind a man's judgment is seen in the attitude of these same Americans towards European practice. They can see no virtue in anything that differs from what they have at home, and entirely fail to grasp the idea that our costly railroads are so built to suit a factor that has less meaning in America —the care of life. An American criticises English railways on the ground that they are built solid to save tractive power, and shows that there are no dollars in the extra outlay, and yet the level crossings in his big cities are like so many slaughter-houses. This he refuses to see in his condemnation of our un-American methods, which to him prove our ignorance. Hence we think that a truly critical training should embrace practical work, either colonial or foreign. The mere academic training of the laboratory, chemical or physical, can do little towards giving a broad basis on which a critical ability should be constructed, as is so plainly seen in the narrow trait of the American mind; for though America is a wide field, and embraces wide climatic differences, it exhibits a severe monotony in all structural and mechanical work.

The want of the proportional sense which Prof. Kennedy lays upon the "prospectus" of public companies is, we fear, more due to the wilful efforts of the knave than to the ignorant stupidity of the fool—to deliberate mis-statement and garbling of facts more than to an inability to comprehend the same, for do we not find such prospectuses backed up by men whose names are to be found on the rolls of the engineering societies. More to the point is his condemnation of the striving to look too far ahead: to fashion work so that it will be up to date about 50 years hence. An instance of this forcibly occurs to us in the miserable failure of the recent Royal Commission on water supply to grasp the simplest facts. They have been so intent on looking 40 years ahead, and finding how to make the present water sources fit a London of ten million inhabitants, that they have overlooked the obvious fact that the present sources are hopelessly polluted by the drainage from thickly-populated valleys of some hundred miles in length.

The Professor concluded his address—of which we have noted but a few of the more salient points—with a sly reference to the mathematicians, asking from them a little forbearance, and promising that when a special mathematical training is given to engineers they will, perhaps, be able to furnish the pure mathematician with many problems for solution, the only drawback to such being that the solution may be really "*useful*," which point, however, it would be well not to bring too obviously before the serene view of the man of science.

We cannot say we think that these addresses of the Presidents of Sections are valuable. Even so able a man as Prof. Kennedy is unable to say much that is new. He simply gathers up a few thoughts, and presents them to us in new clothing. He takes us by a novel route to an accustomed street, which seems new to us when approached from a different direction. A good deal happens in a year, and we should think that had the President given some account of the salient points of his own practice and observation since last the Association met, the value of his address would have been greater. To hear why a certain course was followed, and where it failed to give expected results, or exceeded expectation, is always instructive, and unfortunately there is still with us so much of the old spirit that prompted the ancient millwrights to hang sacking in front of an engine while they set the valves—a sacred operation not to be profaned of the vulgar herd—that young men are frequently compelled to learn by experience, at somebody's cost, things that older and more experienced men already know, but won't tell. The reading of papers which record simple successes, are an example of the tendency to hide instructive failures. It is very largely to the record of failures kept by the boiler insurance companies that the high-class modern boiler owes its existence and safety. They have grouped the failures, and presented them *en masse*, and we have learned thereby how frequent were the accidents that arose from putting the feed inlet below the water level, using a common outlet for steam-pipe and safety valve, and allowing more than one safety valve to discharge into a common waste pipe. The same benefits to other branches would arise if equal publicity could be given to failures and mistakes, of which unfortunately too little becomes known, and to simple facts that have been established. Even though other engineers may disagree with the conclusion drawn, there is invariably discussion of the more important points. The recent paper of Mr. Crompton on his own practice and opinions served to draw forth a great mass of fact from those whose experience was directly contrary to the statements of the paper. In the matter of publishing to the world their own mistakes, our own engineers may take a lesson from Americans, whose society proceedings often contain frank admissions of mistakes made by the speakers and the results thereof, and means taken to repair damages.

PRIMARY BATTERY TESTING.

A very full report, by Prof. A. Jamieson, on a series of tests of dry cells, has recently been published, and is reproduced in this issue. The report is useful as indicating the value of this class of primary batteries, and it is

also useful in that it shows, to a great extent, how tests of the kind ought to be carried out. The determination of the efficiency of any particular battery is not really an easy matter, as there are so many considerations involved; it is not simply a question of what output the battery being tested will give, but how it compares with others which have hitherto been in use. What is the unit of comparison to be? Is it to be bulk, weight, price, or a combination of the three? It must be confessed that it is not at all clear yet what is the most satisfactory answer to this query; Mr. Jamieson has practically taken bulk as the unit, and he is, we think, wise in having done so, and moreover, he has taken cells of as nearly equal size as possible in making the comparisons. As a matter of fact, no other test than that of taking cells of a similar size can be really of value, for it by no means follows that if the size is increased the output should be increased in the same proportion. Of course, if a small cell gives a greater output than a larger one of another type, its superiority is obvious (the question of price being set aside, as it may happen that the smaller cell is actually more expensive than the larger one), but it is not a satisfactory report which states that "the larger cell gave a greater output than the smaller one, as might be expected," for even if dimensions are given we have (as we before stated) as yet not sufficient data to enable one to say how far output goes with bulk. Again, the particular purpose for which the cells are required is a most important element; a steady current for a few hours may be required in certain cases, and in others an intermittent one for a lengthened period. The "time" test is the most difficult one of all to deal with, and, as far as we know, there is no substitute for it; no short period test will really indicate how long a cell will keep efficient when used for such purposes as ringing electric bells. A Daniell battery will work efficiently, and will keep comparatively clean, if more or less continually worked, but keep it idle for a few weeks and its condition will then be a sorry sight. The prospect of a battery with no local action, and one which will give a continuous and steady current when worked, is yet in the dim and distant future; in the meantime we sadly want a really satisfactory system of comparison of the various types which from time to time are brought out.

American Journalism.

The *Electrical World* takes us to task because we commented unfavourably upon the mixing up of a mechanical paper with politics, the occasion being taken to make some rather extravagant claims for "man's greatest political institution," as coeval with the steam engine in birth. We ventured to think the juxtaposition was not a happy one, for the political institution has certainly not prevented the social evils of the Old World being reproduced with increased virulence in the New. To argue from this that we were carping at America or Americans is mere childishness. The very fact that our columns contained in the same issue three leading technical articles of American origin is, we should think, quite a sufficient proof of our respect for what Americans have done and are doing. What we objected to was the dragging in of politics at all. American journals would probably give us quite as severe a handling were we to claim as extravagantly for that political institution of our own country, which is the descendent of that little garden party on Runnymede of June 19th, A.D. 1215, and which certainly was productive of very valuable results to both ourselves and Americans. Quite a number of our readers look on the institution as a failure to-day, but do not admit that England is a failure; neither did we say that America was a gigantic failure. Had we done so we should certainly have apologised, and, as it is, we are sorry our contemporary has so misread what we had to say and has failed to understand that a country may teem with political failures and yet be far from a failure itself. We really think our contemporary is a little unreasonable and considerably unjust in the way it twists what we did say into an attack on America. As well argue that London was a fraud because it is unfortunately saddled with a bad system of government by "bumble."

Electricity as a Registrar of Chemical Action.

The employment of electricity in following the various phases of chemical action was recently described by Mons. J. Garnier before the Paris Academy of Science. The following example will illustrate this novel application. A mixture of nickel oxide and wood charcoal was placed in an earthenware tube, closed by two plugs of soft steel by which the mixture was compressed. The plugs were then connected up to an electric circuit, and the tube with its contents being supported horizontally was heated in a small reverberatory furnace. As might have been presumed, the electrical resistance of the mixture in the tube was at first extremely high, but as the temperature rose it gradually diminished until finally it sank to *nil*. It then began to increase again, and eventually became very high. These phases in the electrical resistance are explained in this way: the decrease corresponds with the gradual reduction of the nickel oxide in the tube by the charcoal, the reduction being complete at the moment when the electrical resistance has attained its minimum; the next change is accounted for by the nickel taking up free carbon, becoming carburetted in fact, and so having its electrical resistance proportionately raised. In other experiments mixtures of copper, iron, and nickel oxides, with wood charcoal, being employed, the successive phases of reduction were again distinctly indicated by variations in the electrical resistance of the mixtures under treatment. It is possible that this system may be adapted to the commercial refining of metals. This is always effected at high temperatures which are difficult to estimate. If a modification of Garnier's experiment were arranged, then sufficient information as to the condition of the contents of the furnace would be given by ammeters and voltmeters installed at any convenient distance from the source of heat.

Electric Muffles: A Suggestion.

From a casual observation which occurs in a recent paper communicated to the Paris Academy of Science by G. Charpy, and dealing with the allotropic changes of iron under the influence of heat, we gather that an electric muffle is now a fairly common adjunct to the metallurgist's laboratory—at least in France. The advantages of electrical resistance in bringing metals to high temperatures which are evenly distributed, and can be elevated gradually, are now recognised in many industries, and are destined to be much more widely exploited. An electric muffle at once suggests the adaptation of the principle of resistance to the "firing" of pottery. When valuable porcelain is "fired" in a kiln heated by means of fuel, many expensive precautions have to be taken so as to prevent the delicate glazes and colours from being impaired by the products of combustion. Small gas kilns and muffles have found a ready sale because the products of combustion of gas are not quite so injurious to porcelain as are those of fuel. Now, since a muffle can be heated to any degree of temperature possible by other methods by means of electrical resistance, and since no fumes or injurious products whatever accompany this use of electricity, it seems to be obvious that electric muffles, and even kilns, would be a success. A Yankee once patented an electrical brick kiln, but this is not quite the sort of thing that is likely to succeed. If small gas kilns and muffles are commercially possible, and an improvement on older methods, surely electric pottery muffles are feasible and would be welcomed.

THE ELECTRICS OF THE ATMOSPHERE.

By E. O. WALKER, C.I.E., M.I.E.E.

It is surprising to notice in the Electrical Review of the 20th ult., a quotation from a paper by Börnstein, in the *Annalen der Physik und Chemie*, in which it is stated that the results of observations go to prove that the potential of the atmosphere decreases with increasing height. It has generally been held to be otherwise. High potentials have been found on the summit of Teneriffe, on the peaks of the Rocky Mountains, and on the Eiffel Tower. Prof. Elihu Thomson refers in a recent lecture also to the Washington Monument as a case in point. It is true that these observations have been taken at points near to, or connected to, the ground, and the high potentials may be due to differences in atmospheric pressure at different points of the earth's surface. Apart from that surface and in mid-air, the conditions may be different. However, we should reasonably expect to find, if electric waves proceed from the sun, that they would first become sensible when they impinge upon the higher atmosphere of the earth, that there the tension would be greatest, and that lower down refraction and reflection would result in dispersion, mutual interference, and consequently a decrease in tension. Until more observations are taken, as suggested in the Review, by balloon, and under different conditions of weather, and in different localities, the view that elevation and high potential subsist together will, I think, continue to prevail generally. One of the most ordinary phenomena of frigid regions, the aurora seems to depend for its *raison d'être* upon the path from the upper atmosphere to the earth being made conductive by intense cold and rarefaction, and permitting of brilliant electric discharge.

It is encouraging to know that the actual electric properties of the air are gradually being elucidated by such complete and convincing experiments as those of Lord Kelvin and Magnus Maclean recently (May 9th) brought before the Royal Society. Here pure air is found capable, as well as smoky or dusty air, of being electrically charged, and it seems that it retains a considerable portion of such a charge for several hours. It is worth while to quote what is said as to the normal condition of the air at and near the earth's surface. "The out-of-doors air potential . . . was generally positive, and the earth's surface itself therefore, of course, negative—the common fair weather condition—which I am forced to conclude is due to a paramount influence of positive electricity in higher regions of the air, notwithstanding the negative electricity of the air in the lower stratum near the earth's surface." Again ("Electrostatics and Magnetism," Art. xvi., Section 282), "even in fair weather the intensity of the electric force in the air near the earth's surface is perpetually fluctuating during calms, or very light breezes from the east, varying from 40 Daniell's elements per foot to three or four times that amount during a few minutes, and returning again as rapidly to the lower amount. . . . These gradual variations cannot but be produced by electrified masses of air or cloud floating by the locality of observation." Further on the authors write: "It is interesting to remark that negatively electrified air over negatively electrified ground, and with non-electrified air above it, in an absolute calm, would be in unstable equilibrium, and the negatively electrified air would therefore rise, probably in large masses, through the non-electrified air up to the higher regions, where the positive electrification is supposed to reside. Even with no stronger electrification than that which we have had within our experimental vat, the moving forces would be sufficient to produce instability comparable with that of air warmed by the ground, and rising through colder air above."

The part played by moving dust particles in our atmosphere is not touched upon, but they must go far to modify the conditions existing in pure air; it is not impossible that the electrification of such particles determines condensation and precipitation of vapour, and it is to be hoped that Mr. Aitken, who has devoted so much time to the study of dusty atmosphere, may complete our knowledge of its properties. There is in the electrical state of the atmosphere a condition which must so profoundly affect the health of the people, that we cannot afford to postpone its thorough investigation.

As a result of observations made in India between 1881 and 1888, I hazarded the conjecture that difference in atmospheric pressure at any two points would occasion an "earth current," if the two were joined by a wire, and the idea was more particularly brought forward and supported by evidence in a paper read by me in 1893 at the Institution of Electrical Engineers (Part 105). It did not seem to find acceptance, because the *rationale* of the process did not cover as well magnetic variations. I think now it will be admitted, after a perusal of the paper of Lord Kelvin and Magnus Maclean, that there are two entirely distinct phenomena to be dealt with, and those who undertake to investigate "earth currents," must be prepared to find the two sometimes operating together and sometimes separately. The quietly and gradually changing earth currents, often found in India, particularly between inland places and those on the sea coast, or between places of different elevation, are due to the changes in electric potential of the atmosphere, which accord with Lord Kelvin's observations; the currents are the stronger when the atmospheric pressure is changing more rapidly at the one place than the other, for instance, at a highland and a lowland station; that is, when the effect of solar radiation is communicated at a quicker rate at the one place than the other. The tendency is, when the two places are joined by a conductor, towards equilibrium of electric pressure at both ends, but since the forces producing the difference of potential are in continual operation there is a current. I have very often experienced a difference of 2 volts, often less, sometimes 5 volts; in the cable, Madras to Penang, over 14 volts have been observed. I am referring now to quiet days when the magnets are not abnormally disturbed, and I have shown in my paper of 1893 that these "electro-atmospheric" currents only gradually change in force. It is very likely that the observations on Ben Nevis may show the same class of phenomenon. When clouds condense there, or rain or snow falls, a current flows from the summit to the base, and the direction is reversed as the cloud leaves, the mists rise, and moisture is re-evaporated. In dry air, and in the absence of vapour, we must now accustom ourselves, in the light of Lord Kelvin's experiments, to believe that the same process goes on when movements of the air are occasioned by differences of temperature and so of pressure.

Quite a different phenomenon would appear to be that affecting a suspended needle in its daily variations. The force is so small, that its effects in creating currents in our telegraph lines are on most days obscured by those of "electro-atmospheric" potential. It is not impossible that it may be attributable to the lagging behind in high regions of magnetised crystals of frozen oxygen, and the incessant evaporation and re-arrangement of these crystals under the action of solar heat. According to the position of the earth relative to the sun, the direction of the lines of these crystals would vary, and cause a distortion of the earth's magnetic field, varying according to time of day and season of the year, and a consequent modification of the position of the needle. Some colour is lent to this hypothesis from the fact that the curves of declination at Madras vary with the position of the sun north and south of that place. But can large disturbances, such as produce violent currents in our wire circuits, simultaneously with swinging of the needles, be accounted for either by greater "lagging behind" or irregular movement of magnetised matter in the upper atmosphere? There seems to be no evidence to prove it, and it can only be hoped that the close attention given to the question by Mr. William Ellis, F.R.A.S., may be applied without intermission to the elucidation of the mystery, and that the question may be studied intimately and concomitantly with solar physics. In Mr. Ellis's paper, read before the Royal Society on May 5th, 1892, he showed how, by actual observation, definite and rapid movements of the magnets occur at times of disturbance simultaneously, or nearly so, all over the earth. The observations were taken at Toronto, Greenwich, Pola, Pawlowsk, Mauritius, Bombay, Batavia, Zi-ka-Wei and Melbourne. At Greenwich, Mr. Ellis says, such sudden magnetic movements are always accompanied by corresponding earth currents. We know that the solar diurnal variation for each place takes place according to local time, that is, the needle moves on its even sweep later at places west than at places east, so that the unusual magnetic impulses cannot be merely an increase or decrease of the force ordinarily causing variation, but a manifestation of

a force of another character, by which the intensity of the earth's magnetic elements is increased or decreased suddenly from the normal.

I cannot help noticing, in conclusion, that Mr. Ellis, speaking from his experience of the Greenwich Observatory earth current lines, says that the "diurnal magnetic variation of declination or horizontal consists principally of one bold daily sweep, has no corresponding earth current, being accompanied principally by alternating currents, weak in character, and generally of short period. . . . In the absence of magnetic disturbance there exists practically earth current calm." That is, the lines are so short, and the atmospheric conditions at Greenwich are so similar to those at the other terminals of the lines, that there are no "electro-atmospheric" manifestations, and that except during "magnetic storms," only feeble thermo-electric currents, and those due to mechanical concussions in the neighbourhood of the earth plates, are observed.

In the study of these most interesting subjects, we shall hope to see all the factors that contribute to make the phenomena complex, evolved, and the *modus operandi* of each explained. There can be no doubt that in much that has been written and discussed in the past, observers have unintentionally been confusing different causes and effects.

THE INCANDESCENCE LAMP.*

By A. BAINVILLE.

(*Continued from page* 131.)

The Extraction of the Air or the Forming of the Vacuum.

We must now proceed to the extraction of the air from the bulb into which the glass blowers have introduced and fixed the filament.

We may say that this operation is the most important of all the operations involved in the making of an incandescence lamp, and at the same time the one that requires the strictest attention to the most minute detail. There cannot be a good lamp without a good vacuum, and the better the vacuum the better the lamp. If we can, in an emergency, make mediocre lamps with mediocre filaments, we can have nothing but bad lamps with a mediocre vacuum. If we add that the lamp manufacturer has only imperfect, or at any rate unpractical, methods at his disposal for this important work, we can easily understand what pains he must take in order to obtain good results. We shall presently see how many disturbing elements there are, and how difficult it is to get rid of them or overcome them.

These difficulties have naturally led to attempts to do away with an operation which is besides the most costly in the whole manufacture in consequence of the numerous appliances required for it. These endeavours have not, however, as yet, met with any success. Attempts have also been made to simplify the work as far as possible, by modifying the conditions so that a less perfect vacuum would answer the purpose required. It is certain that a solution of this kind would lessen both the cost and the difficulties of the operation. The process by which the air is replaced by an inert gas is an attempt in this direction. Unfortunately this process only gives good results on condition that the vacuum is rendered as complete as if the bulb was filled with air; it thus loses all its advantages, and only creates a fresh complication in the manufacture.

We will carefully examine the *rôle* that is played by the vacuum in the incandescence lamp.

The main object of this operation is, no doubt, to prevent a combustible thread from being subjected to the action of the oxygen in the air. It seems evident, reasoning *à priori*, that by suppressing the causes of the combustion we also suppress its effects and that, consequently, the duration of the filament, under such conditions, would be infinite. This reasoning would be correct if secondary causes, not at first suspected, such as the molecular straining produced by the current, the disintegration of the carbon, &c., did not greatly restrict the limits of this duration, limits, moreover, which vary according to the working of the lamp.

But, besides this essential reason for a vacuum in the bulb of the lamp, there are others of almost as much importance, such as the expenditure of energy required to keep up the incandescence.

The incandescence lamp is, in fact, only a very rough mode of transforming electrical energy into luminous energy. The efficiency of this transformation, notwithstanding the progress made, is, as yet, extremely low. It is, therefore, all the more necessary to eliminate all the causes that are likely to reduce this efficiency. The calorific conductivity of the medium by which the filament is surrounded has a considerable influence on the consumption of energy of the lamp. The less conductive this medium is, that is in the case of any particular gas, the more rarefied this gas is, the smaller will be the loss of energy from this cause; and, again, in this particular atmosphere the losses by convection will also be much less. By obtaining a vacuum we, so to speak, suppress an expenditure of energy which in no way contributed to the production of the light, and from this we may conclude that the more perfect the vacuum, the more economical will the lamp be. These conclusions, as we see, condemn the lamps with an atmosphere of inert gases mentioned above.

We can easily obtain unmistakable evidence of the influence of the vacuum on the consumption of energy. If we take in our hands two lamps, identical in form, of the same luminous power and the same total consumption, but one of which has an indifferent vacuum and the other as perfect a vacuum as possible, and we start them both at the same moment, we shall soon be obliged to let go the one with an imperfect vacuum, the bulb so quickly attains a high temperature, whereas, the other, is only heated very slowly, and never becomes too hot to hold.

This rough method moreover shows, when one is acccustomed to the manipulation of the lamps, whether the vacuum is good. It is very evident that the ratio of the volume of the bulb to the quantity of energy expended in the lamp, plays an important part, and that we cannot compare a new lamp with one in which the bulb is even slightly blackened. This quantity of heat is no doubt taken from the filament; if the two lamps have bulbs of the same external surface and are placed under similar conditions, the temperature of equilibrium which they attain at the end of a certain time is certainly in proportion to the loss of energy resulting from the radiation of the filament and the conductivity of the atmosphere by which it is surrounded; as the first of these causes depends solely on the nature of the filament, the temperature, for lamps of the same type, is certainly a function of the degree of perfection of the vacuum in the lamps.

Amongst the qualities that the operation of forming the vacuum develops in the incandescence lamp, we may also mention the small quantity of heat given off by it. It is this quality that leads to the adoption of this kind of lighting for so many applications, and the more perfect the vacuum the less heat is given off.

These few considerations fully justify what we stated at the beginning of this article, and show yet more clearly that the lamp maker should endeavour to obtain as perfect a vacuum as possible. We will now see what means he has at his disposal for successfully carrying out this delicate operation.

The process employed in all lamp factories for obtaining a vacuum is based on the employment of mercury pumps. Numerous attempts have been made to substitute for these delicate instruments, which besides work very slowly, mechanical piston or rotatory pumps; but as we have before said, these attempts have up to the present been unsuccessful. The best vacuum that has to our knowledge been obtained with mechanical pumps is far too imperfect for the incandescence lamp.

A few years ago, an American pump created a certain sensation, and it was even said that the blackening of the lamps might be avoided by using this pump, as, so it was said, this blackening might be attributed to the mercury employed in the apparatus in use. Without troubling as to whether there was any truth in this assertion, I endeavoured to procure reliable information as to the merits of this pump; I only succeeded in obtaining an enthusiatic enumeration of

* *L'Electricien.*

all its virtues, but was unable to obtain any serious details as to its working or construction.

An ingenious apparatus invented by M. F. de Romilly, and designated by him by the name of "pnéole," figured at the Exhibition of 1889. This apparatus consists essentially of a turbine turning at great speed and raising by centrifugal force a certain quantity of mercury which is contained in a horizontal fixed tube which is bent vertically. The mercury held in this tube meets an adjutage formed of two truncated cones with their small bases facing one another and separated by a free space.

The orifice of the cones is reduced to a circular slit by a little metal cylinder which passes into the two openings and the axis of which is the same as that of the cones. If the free space between the cones is shut in an air-tight enclosure, the mercury by crossing this space will produce a vacuum. We have then only to connect this space with the capacities to be exhausted. The working of this apparatus is similar to that of the Sprengel pump, of which we shall speak presently, and in which weight is substituted for centrifugal force. It certainly works more quickly on account of the greater speed of the mercury; but, owing to this very speed, the mercury becomes considerably heated and the vacuum obtained is consequently not so perfect. Moreover, the delicate and costly construction of this instrument has prevented it from coming into practical use.

In short, therefore, we must say that the difficulties in the way of the establishment of mechanical pumps producing as perfect a vacuum as the instruments now in use, have not as yet been overcome. We can only suppress escapes through the pistons and valves by immersing them in a liquid, and this liquid, if we do not use mercury, gives off vapours the tension of which prevents the production of a perfect vacuum. Even if mercury is used, the violent movements and compressions to which it has necessarily to be subjected raise its temperature and thus render the vacuum obtained less perfect.

We shall, however, presently see that the employment of mechanical pumps renders useful service on condition that they are only used as auxiliaries at the commencement of the operation. They are not then required to produce a perfect vacuum and much simpler instruments may give excellent results.

(To be continued.)

THE ELECTRO-CHEMICAL RELATIONS OF CARBON AT HIGH TEMPERATURES.

By E. E. BROOKS.

The problem of obtaining electrical energy from the direct combustion of carbon, apart from any commercial considerations, is so interesting, theoretically, and so little is known concerning the behaviour of carbon in fused salts, that I think a short account of experiments carried on during intervals of leisure for several years may be of some service, at any rate, as a guide to other investigators.

Apparently, there are only two possible ways of dealing with the carbon: the first being direct combustion, the second, making it the positive plate in some voltaic combination.

The thermopile is the only known application of the first method, and unless some kind of Hertzian receiver can be used to transform radiation into current, there is nothing whatever to suggest in what direction we are to look for a solution. Certainly there seems to be no way of getting more directly at the combining elements; and, indeed, if we compare the actions going on in a voltaic cell with those of combustion, from the point of view of atomic charges, it seems to indicate that combination in itself is insufficient, and that electrical energy can only be given to an external circuit when decomposition also occurs.

The voltaic method has frequently been attempted. I believe Jablochkoff suggested, as a commercial possibility, the use of a cell composed of carbon and iron in fused potassic nitrate, and other experimenters have used carbon and nickel in a mixture of fused oxides. The potassic nitrate reaction is especially unsuitable, being apt to become uncontrollably violent; while, in any case, much of the salt is decomposed uselessly. In all such methods, the first obstacle lies in the difficulty of finding a fitting material for the negative plate, as expensive metals, such as platinum, are really out of the question, while the others tend more or less to oxidise, and this means both back E.M.F. and bad contacts. I was for a long time under the impression that a metallic substance would be absolutely necessary for this purpose, but I never obtained any really satisfactory results until I abandoned the use of metals altogether.

Another point that should not be overlooked lies in the change of state of the carbon when oxidised. I find the heat of combination of one equivalent of carbon with oxygen to form CO_2, given as 24,240 calories, and this gives a calculated E.M.F. of 1·05 volts. This is a low value for so intense a reaction, and is, of course, due to the fact that a large amount of energy is expended in changing the molecular state of the carbon. Consequently the E.M.F. of the CO reaction would be still lower in comparison, and apparently would not be more than about ·09 volt. We must not understand this to mean that these values cannot be exceeded under any circumstances, because experiment shows that an E.M.F. reaching nearly 2 volts may be obtained under suitable conditions, the explanation probably being that some of the energy expended internally may be supplied from sources independent of the reaction itself.

Carbon may be used as a positive element in strong, boiling, sulphuric acid, although the cold acid gives little, if any, result. I have obtained an E.M.F. of about ·22 volt, using a small piece of platinum as the negative element.

A rather curious result may be obtained by dipping a piece of clean platinum foil first into melted sulphur at a high temperature, and then into water, the foil being thus covered with a thick film of plastic sulphur. This sulphurised plate, when opposed to a clean platinum plate in hot, strong sulphuric acid, will act as a zinc, and give an E.M.F. of at least ·15 volt. The plate used as above may then be held in a Bunsen flame until the sulphur is burnt away, and it is quite clean again, and the other plate be simply rubbed with a little plastic sulphur, so that some of it adheres. A similar result will be obtained, though lasting for a shorter time, the direction of current having, of course, changed. Phosphorus behaves in the same way, only it is rather difficult to make it adhere to the platinum.

It may be useful also to mention one or two other effects met with in the course of these experiments, and which, although only indirectly bearing upon the subject, gave me some little trouble to clear up satisfactorily.

Bind a piece of copper wire tightly round the end of a small carbon rod, say $\frac{1}{4}$ or $\frac{5}{16}$ inch diameter, thus forming a carbon-copper junction. Connect the arrangement to a suitable galvanometer or voltmeter, and put the junction into a small red hot crucible. A slight thermo E.M.F. will be obtained, the current direction being from carbon to copper through the junction, though with a voltmeter, perhaps, this E.M.F. will be too weak to be recognised. If a few fragments of sulphur are now thrown into the crucible, it will become filled with sulphur vapour. This will burn at the top of the crucible, and the copper will become incandescent in it, forming sulphide of copper (CuS), and an E.M.F. will be obtained, direction of current being from copper to the carbon through the junction, which may reach ·2 volt, but which will probably average about ·1 volt. At first sight this E.M.F. seemed rather high for a thermo effect, and the question arose as to whether the chemical action had any influence upon the result. Consequently an experiment similar in principle was tried with chlorine gas. A copper-carbon junction was placed in a glass tube, and chlorine gas passed over it, the tube meanwhile being heated over a Bunsen in order to accelerate the reaction. The copper became covered with a brown coating of anhydrous copper chloride, $CuCl_2$, and eventually became incandescent in the gas, an E.M.F. of about half a volt being indicated. The experiment was repeated several times, and it was noticed that at a particular instant the chloride suddenly fused, and that the voltmeter deflection occurred almost simultaneously. After most of the copper was consumed, and the flame removed, sudden irregular throws occurred during the cooling, reaching ·8 volt for a short time. These results seemed so suggestive of electrolysis that an experiment was made with

small rods of carbon and copper in fused $CuCl_2$, the result being that the copper rapidly dissolved, giving an E.M.F. of about ·8 volt, and thus, of course, explaining the origin of the E.M.F. in the preceding experiment. The source of the E.M.F. in the case of sulphur was eventually traced to a thermo effect between copper sulphide and copper, or rather to a difference of two thermo effects, there being both a carbon-CuS, and a CuS-copper junction setting up opposing E.M.Fs., the voltmeter merely giving the resultant.

Attention being thus directed to copper sulphide, rods of this material were made by burning copper wire in sulphur vapour, the product being hard and close grained, with a glazed exterior, and a crystalline fracture, but rather brittle. I measured the resistance of various specimens, and in the case of rods prepared from No. 12 gauge copper wire, found it to vary from rather less than ·04 to ·06 ohm per inch of length. It was found to be most powerfully thermo-negative, giving about ·2 volt at a red heat, even with so negative a metal as antimony. A CuS-nickel junction gave ·3 volt, and a CuS-carbon junction about ·15 volt, at a red heat. On one occasion a stick of copper sulphide, a few inches long, and a nickel wire, were attached to a voltmeter and placed in an ordinary open fire, some distance apart. A steady deflection of about ·17 volt was obtained, which remained constant a long time; in fact, while the experiment lasted. German silver in place of the nickel seemed to give a little more, but speedily burnt and disappeared. Iron gave ·15, and copper ·1 volt, under the same conditions.

This thermo-electric property of copper sulphide seemed to account for another result that had puzzled me. I had some old and dirty hessian crucibles, which had been used for various purposes, and were saturated with the substances used, and I happened to find that when one of them was put in a fire and a stick of carbon placed within it, only touching it at the bottom or side, and another carbon in the fire outside, a steady E.M.F. of as much as ·2 volt could be obtained between them, the direction of the current internally being always from fire to crucible. Experiment seemed to indicate that this result depended upon the presence of copper and sulphur, and the direction of current corresponded to a thermo-effect between the hot coals of the fire, and the substance in the walls of the crucible. Whether this explanation is correct or not, the experiment served to call attention to a fact I have frequently had occasion to notice for some years past, namely, the remarkably high conductivity of burning coke or coal, in spite of the effective surface being much reduced by imperfect contact. This is especially noticeable in the case of a forge, not because a high temperature is required, but because the small clean fragments lie closer together, and make much better contact than the larger coals of ordinary fires. The experiment also suggested the idea of using crucibles in the same way as porous pots, and was the starting point of a large amount of work in that direction. In nearly all the following experiments I used small hessian crucibles about 3 inches long by 1½ inch diameter at top; the carbon rods were $\frac{5}{16}$-inch arc carbons, and the copper sulphide was in the form of rods made from No. 12 or 14 gauge wire, usually only about 1 inch of the rods being immersed in the fused material.

I first fused some potassic nitrate, placed one carbon in the crucible, and another carbon in the fire outside, and obtained an E.M.F. of ·4 volt at a moderate temperature, the rod in the crucible acting as the zinc of an ordinary battery. This avoided the use of a negative metal, but introduced opposing E.M.Fs., and as there did not seem much to be gained by it, I made a series of experiments on the use of copper sulphide as a negative material before returning to this method of working.

When rods of CuS and carbon were placed in fused potassic nitrate, an E.M.F. of ·6 volt was instantly obtained, and when the reaction became rather violent, more than 1 volt was indicated. The CuS was attacked as well as the carbon, and on examining the residue it was found to contain a considerable quantity of an insoluble light blue salt which turned out to be a carbonate of copper. Potassium sulphate was also present in quantity, but I was rather surprised to find no trace of copper sulphate.

A fused mixture of potassic and sodic carbonates was tried in the same way, the result being an E.M.F. amounting at times to more than half a volt, and which remained steady at ·3 or ·4 volt for a long while, the internal resistance varying in different experiments from ·6 to 2·6 ohms. When a rod of nickel was substituted for the copper sulphide, the E.M.F. fell at once to ·17 volt. The residue in this case did not yield any copper carbonate, except a little after it had been boiled with water, and then it was to be expected from the action of the undecomposed carbonates upon the copper present. The carbon was probably only oxidised to carbonic oxide, and hence the absence of carbonate. Potassium sulphate was formed as before, but no copper sulphate.

(To be continued.)

OXFORD CHEMISTS.

Prof. Dixon, F.R.S., as President of "Section B" of the B. A., gave an address which took the form of a most interesting biographical sketch of the old Oxford chemists—Robert Boyle, with his disciples Hooke and Mayow. In those early days, the Papal dictum had gone forth against progress in philosophy, that men "must be content with the landmarks of science already fixed by their fathers, and have due fear of the curse pronounced against him who removeth his neighbour's landmark;" and popular feeling was very bitter against the advance of the new learning. Boyle, "in spite of his private position, his blameless life, his devoutness, and his charity," was attacked in the University pulpit, and in public orations; his theories were described as destructive to religion, and his experiments were denounced as undermining the University. Indignation was expressed that he, a gentleman by birth and fortune, should concern himself with "low mechanical arts." "Against these attacks Boyle replied with irresistible logic; his vindications of the nobility of scientific work constitutes one of his greatest claims on our gratitude."

Robert Boyle was born in 1626, in the same year that Francis Bacon died; the period of his life, contemporaneous with that of Newton, marks at once the downfall of the cramped philosophy of the Middle Ages, and the uprise of the rational study of mechanics, chemistry, and physics, Hooke was an assistant in Boyle's laboratory; in 1662 Boyle obtained for him the curatorship of the London Society, afterwards known as the Royal Society, and together they worked in the investigation of the constitution and character of the air, and the theory of combustion. John Mayow, Fellow of All Souls, further developed the work, showing that air was compounded of two gases; he detected the existence of oxygen in the air, and demonstrated some of its most remarkable properties.

The President concluded his address by drawing a comparison between the results brought about by these old Oxford chemists, and the tardy growth of chemistry at Oxford at the present day, adding some valuable suggestions with a view to reforming the dismal state of affairs which now exists.

TERRESTRIAL MAGNETISM.

As President of the "Mathematics and Physics" Section of the B. A. meeting at Oxford, Prof. A. W. Rücker, F.R.S., opened with an address upon some of the results of the British magnetic survey with which he has been connected for the last ten years; he brought to notice matters of fundamental importance as to the accurate measurement of declination and horizontal force, with regard chiefly to the adjustment and manufacture of standard instruments; he further pointed out the need for reform in the computation of results, and the necessity for a universal system of standardising so-called "standard" dip-circles and magnetometers. The address ended with some notes upon modern theories of the earth's magnetism, with special reference to the origin of regional and local disturbances.

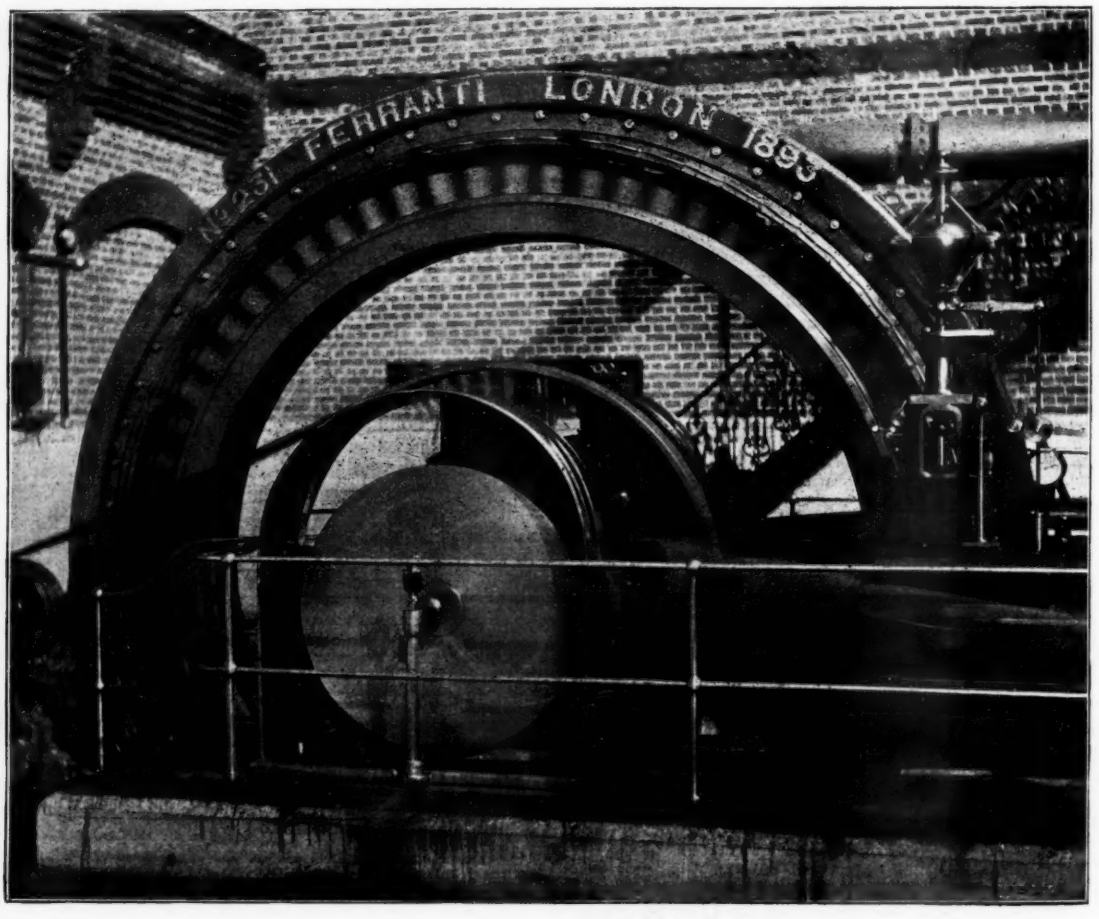
It is rather prejudicial to our faith in the figures evolved from the great observatories to be told that there is a serious discrepancy in the absolute values, and we are glad to know that investigations are under consideration as to the cause of

errors. Local magnetic surveys have been actively organised within the last few years throughout a very wide area, and Prof. Rücker points out that the results can only be collated and welded into a homogeneous whole by an international comparison of standards. It is proposed that this should be done for one observatory in each country, and that each country should, from this observatory, adjust or compare all its other instruments; it is thus left to each nation to determine for itself the relations between the results of measurements made in its own institutions. The question of the choice of days was also shown to affect the interchenge of results, so that the mean readings depend upon whether the computations are made from tests taken on days of magnetic calm or storm. Some convention is to be hoped for, and, to this purpose, Greenwich will in future give us two diurnal variations, one obtained from the most quiet days only, the other from all days except those of violent storm, and in these we shall have most valuable data for studying the mean effect of disturbances on the diurnal variation.

The causes of regional and local disturbances are questions for the geologist as well as the magnetician. Prof. Rücker believes "that the presence of magnetic matter, magnetised by induction in the earth's field, is the principal cause of the existence of the magnetic ridge-lines and foci of attraction." He mentions, as the final and conclusive argument, that "every great mass of basic rock by which the needle is affected at considerable distances attracts the north-seeking pole. Captain Creak some years ago showed that the same statement is true for those islands in the northern hemisphere, which distnrb the lines of equal declination, while islands in the southern hemisphere repel the north pole and attract the south. In other words, these disturbances are immediately explained if we suppose that they are due to magnetic matter, magnetised by induction. The theory of earth currents would, on the other hand, require that round the masses of visible basalt, and round the island investigated by Captain Creak, currents, or eddies in currents, should circulate in directions which are always the same in the same hemisphere, and always opposed on opposite sides of the equator." This seems sufficiently conclusive against the hypothesis of earth currents; and, while we can no longer hold such currents to be the primary feature in magnetic disturbances, the theory of the magnetic induction of magnetic rock will probably show them to be a secondary phenomenon intimately connected with those variations.

A SYNCHRONOUS PHOTOGRAPH.

FEW processes within the last few years have made greater strides than photography, especially in the instantaneous branch of the art, but the photo illustrated herewith is, it is believed, a novelty. It is a synchronous photograph, if we may so express it, in contradistinction to an instantaneous one.



It was taken one evening at Portsmouth, and shows one of the Ferranti 212 kilowatt slow speed steam dynamos when running at 96 revolutions per minute. The length of exposure was 10 minutes, and thus the fly-wheel made nearly 1,000 revolutions during the exposure, the engine room being lighted by alternating current arc lamps run off the dynamo itself.

Readers of the ELECTRICAL REVIEW of June 8th, in which a full description of the Portsmouth Corporation Electric Light Station was published, will remember that the dynamos are of Mr. Ferranti's new type, and have 64 field magnets mounted radially round the periphery of the engine fly-wheel. The magnet coils consist of bare bright copper strip, lacquered.

The photo shows that the field magnets and fly-wheel are apparently stationary and held in space, no arms or other means of support being visible, and so perfect is the original photograph, that one can count the number of convolutions on each field magnet coil. The circular crank disc is, of course, sharp and distinct, but the crank pin and connecting

rod are entirely wanting, and the piston rod appears only as a vague shadow.

This curious optical effect was noticed the first evening the engine room was lit by alternating current arc lamps; it is non-existent when incandescents only are used. The periodicity of the Portsmouth current is 50 cycles per second, or, say, 100 alternations, and during each alternation the current—and consequently the light in an alternating current lamp—varies between a maximum and a minimum, and the maximum light always corresponds to a given position of any rotating field magnet relative to a fixed armature section.

The retina of the eye is naturally affected most, and receives its impression at the time of maximum light, and the persistence of the impression thus received continues until, by the rapid rotation of the fly-wheel $\frac{1}{64}$th of its periphery, a fresh field magnet is advanced to occupy the position of the previous one, thus causing a repetition of the image.

Similarly, in photography, the maximum sensitiveness of a plate is synchronous with maximum light, and consequently with a fixed position of the field magnets relatively to the armature coils, hence the distinctness of the photo herewith.

The effect is most strikingly shown when a second machine is started from rest, and is being run up to synchronous speed. When it has attained half speed its magnets appear to be stationary, but of half their proper pitch, *i.e.*, instead of 64, 128 are seen. When the machine is approaching synchronism the field magnets seem to have a rotating action opposite to their real direction of rotation. They, of course, appear stationary at synchronous speed, whilst when running over speed they appear to rotate slowly in the direction in which the fly-wheel is running, and by following with the eye the rotation of a given bobbin and speeding it, one can tell how much faster one plant is running than the other.

This optical effect greatly facilitates the speedy synchronising of two dynamos, as when the magnets of the fresh machine appear stationary, the drivers know immediately the machines have attained true synchronism, and when running up can see how much faster or slower the plant ought to run.

The open nature of the dynamo and bright copper of the field magnets considerably assist in showing the effect.

It is also interesting to so place oneself that the armature of a running dynamo is between the eye and an alternating arc lamp, the points of the lamp being seen through the radial air gaps between the field magnets. By slowly altering the position of the head, the arc can be made to appear of any luminosity from full power to dim red, due to the interception of the light by the field magnets, except at one given time during each alternation, and to the persistence on the retina of the eye of the impression then left.

In conclusion, it should be stated that in the running of both the alternating and the commutated arc lamps at Portsmouth there is no suspicion of flickering or vibration of light due to the low periodicity adopted, and so satisfactory has the public lighting been, that an immediate extension is projected, if not already in hand.

The opening of the Portsmouth station has certainly marked an important era in central station design, and the novelties then introduced for the first time, which reflect great credit on Mr. Ferranti and all concerned, after some months' public trial, are being adopted in the new stations now projected and starting. Thus in Ayr slow speed engine alternators (Siemens) will be erected, whilst Mr. Ferranti's patented arc light system will be employed at Cardiff, Tunbridge Wells, Edinburgh and Islington, and probably at some of the older stations as well.

These results must of necessity be most gratifying to the consulting engineers, Messrs. Kincaid, Waller & Manville, who had the courage of their convictions in introducing novelties, and to whose foresight and work at Portsmouth much credit is due.

INDUCTIVE TELEGRAPHY; AND TELEGRAPHIC COMMUNICATION BETWEEN LIGHTSHIPS AND THE SHORE.

At the meeting of the Society of Arts, in the discussion following a paper by Mr. E. O. Walker, on "Telegraphic Communication with India," one speaker said "I don't know much about submarine cables, but I should think land lines were better" (!) and in this several others who took part in the discussion appeared to agree—possibly on the same grounds. In this instance, the question was whether a land line through a thickly wooded desert country, or a submarine cable in shallow water and on an even, soft, bottom was the best adapted as a means of communication.

Notwithstanding the difference in initial cost between a land line and a cable, we were not, on the occasion referred to, able to agree with these gentlemen in their preference for an aerial line.

In cases, however, where inductive telegraphy is found to be practicable, the matter stands on a different footing entirely, and there is no doubt that the experimental investigations of Mr. C. A. Stevenson, F.R.S.E., on "Signalling Through Space," referred to in our last issue, and previously of Mr. W. H. Preece, F.R.S., (following on others of Mr. Willoughby Smith and Mr. W. P. Granville, besides those undertaken by Mr. W. F. Melhuish across Indian rivers) have a most important practical bearing on commercial telegraphy.

The direction in which these experiments (sometimes popularly described as "telegraphy without wires") are likely to be turned to the best account in practice, in the immediate future, is presumably in connection with telegraphic communication between lightships and the shore, where great difficulty is experienced in maintaining electro-telegraphic communication by means of submarine cables, owing to the cable getting chafed against the moorings of the lightship, and owing to the bottom in such regions being so unfavourable to a cable—indeed, the very reason why telegraphic communication is required at all is due to the somewhat frequent occurrence of wrecks in the immediate vicinity, the lightship itself being usually placed to mark a reef of some sort; if, moreover, a strong current prevails, as is not uncommonly the case, the cable is liable to get shifted and twisted up with the lightship moorings.

The Telegraph Construction and Maintenance Company have made a special study of this subject, but notwithstanding several ingenious devices of Mr. F. R. Lucas, Commander F. Bedwell, R.N., and others, the objections named have not so far, we believe, been entirely overcome.

It will be observed, therefore, that one obvious solution of the problem will be—if it be possible, as demonstrated by the aforesaid experiments—to carry on these electric signals between lightships and the mainland without any cable whatever running between the signalling points.

The same practical field for these investigations appears to apply in the case of electrical communication across rivers, and such like, in which the bottom (for one reason or another) is so unfavourable, or the danger of abrasion from anchors or moorings so great, that the life of a submarine cable across it would be of too problematic a character.

The distances between which signalling by inductive telegraphy can be successfully performed in practice is, of course, the only point in question. At present this distance seems to be of a somewhat limited nature, though in the recent experiments carried out for him by Messrs. J. Gavey and H. R. Kempe, Mr. Preece appears to have successfully effected communication at far greater distances than had been previously attained. The results of these experiments were made public at a recent meeting of the Society of Arts and rendered palatable to the audience by Mr. Preece in a manner in which he alone knows how.

Perhaps on a future occasion Mr. Preece will be able to actually furnish us with some law giving the maximum distance at which telegraphy, or telephony, of this description is practicable, and what relation this distance must bear to the length of wires ashore, whether parallel to each other or otherwise. Possibly, someday, when further light is brought to bear on the subject, we may be able to signal in this way for many hundreds of miles across the ocean without any submarine cable between the signalling points, but, for the present, the cable-constructing companies, as well as telegraph engineers and electricians, may be thankful that this time has not yet arrived!

In this connection we would venture to ask Mr. Preece, and others treading in the same paths of investigation, to try to unearth some other title for any future experiments of the sort, if only on behalf of shareholders of cable manufacturing companies who are liable to be alarmed at the near prospects of "telegraphy without wires." In point of fact—

as put by Mr. Charles Bright at the meeting referred to—it is, in reality, a case of the wires being laid more or less parallel to one another, and being of a length more or less corresponding to the distance between the points of signalling instead of from signalling point to signalling point. At any rate, it looks as though material lengths of cable or wire will still be required! At the same meeting, Mr. Alexander Siemens mentioned what seems to be a sufficiently good reason for explaining the phenomena as due to electro-magnetic induction rather than to conduction, thereby upholding Mr. Preece's explanation of the same—by the ether theory—rather than Mr. Granville's.

THE BRITISH ASSOCIATION.

PRELIMINARY EXPERIMENTS TO FIND IF SUBTRACTION OF WATER FROM AIR ELECTRIFIES IT.

By Lord Kelvin, P.R.S., Magnus Maclean, M.A., F.R.S.E., and Alexander Galt, B.Sc., F.R.S.E.

(*Read before Section A, August 9th.*)

Experiments with this object were commenced by one of us in December, 1868, but before any decisive result had been obtained, circumstances rendered a postponement of the investigation necessary.

A glass U-tube with vertical branches, each 18 inches long and about 1 inch bore, with the upper eight inches of one of the branches carefully coated outside and inside with clean shellac varnish, was held fixed by an uninsulated support attached to the upper end of this branch. The other branch was filled with little fragments of pumice soaked in strong pure sulphuric acid or in pure water; and a fine platinum wire, with one end touching the pumice, connected it to the insulated electrode of a quadrant electrometer. A metal cylinder, large enough to surround both branches of the U-tube without touching either, was placed so as to guard the tube from electric influences of surrounding bodies (of which the most disturbing is liable to be the woollen cloth sleeves of the experimenters or observers moving in the neighbourhood). This metal tube was kept in metallic connection with the outside metal case of the quadrant electrometer. The length of the exposed platinum wire between the U-tube and the electrometer was so short that it did not need a metal screen to guard it against irregular influences. An Inda-rubber tube (metal metallically connected with the guard cylinder would have been better) from an ordinary blowpipe bellows was connected to the uninsulated end of the U-tube. Air was blown through it steadily for nearly an hour. With the sulphuric pumice in the other branch the electrometer rose in the course of three-quarters of an hour to about 9 volts positive. When the pumice was moistened with water, instead of sulphuric acid, no such effect was observed. The result of the first experiment proves decisively that the passage of the air through the U-tube gave positive electricity to the sulphuric acid, and therefore sent away the dried air with negative electricity. A corresponding experiment with fragments of chloride of calcium instead of sulphuric pumice gave a similar result. In repetition of the experiments, however, it has been noticed that the strong positive electrification of the U-tube seemed to commence somewhat suddenly when a gurgling sound, due to the bubbling of air through free liquid, whether sulphuric acid or chloride of calcium solution, in the bend of the U-tube, began to be heard. We intend to repeat the experiments with arrangements to prevent any bubbling of the air through liquid.

We have repeated our original experiment with pumice moistened with water in the insulated U-tube, and with an uninsulated U-tube filled with sulphuric pumice between the bellows and the insulated tube, so that the air entering it is artificially dried. With this arrangement the insulated U-tube was negatively electrified by the blowing of the air through it; but this electrification may have been due to the negative electrification of the dry entering air to be expected from the result of our first experiment. We intend to repeat the experiment with artificially dried *and dis-electrified* air blown through the U-tube containing pumice moistened with water.

PRELIMINARY EXPERIMENTS FOR COMPARING THE DISCHARGE OF A LEYDEN JAR THROUGH DIFFERENT BRANCHES OF A DIVIDED CHANNEL.

By Lord Kelvin, P.R.S., and Alex. Galt, B.Sc., F.R.S.E.

(*Read before Section A, August 9th.*)

In these experiments the metallic part of the discharge channel was divided between two lines of conducting metal, each consisting in part of a test wire, the other parts of the two lines being wires of different shape, material, and neighbourhood, of which the qualities in respect to facility of discharge through them are to be compared.

The two test wires were, as nearly as we have been hitherto able to get them, equal and similar, and similarly mounted. Each test wire was 51 cm. of platinum wire of ·006 cm. diameter and 12 ohms resistance, stretched straight between two metal terminals at the ends of a glass tube. One end of the platinum wire was soldered to a stiff solid brass mounting; the other was fixed to a fine spring carrying a light arm for multiplying the motion. The testing effect was the heat developed in the test wire by the discharge, as shown by its elongation, the amount of which was judged from a curve traced, by the end of the multiplying arm, on sooted paper carried by a moving cylinder. Two of Lord Kelvin's vertical electrostatic voltmeters, suitable respectively for voltages of about 10,000 and 1,500, were kept constantly with their cases connected with the outer coatings of the Leyden, and their insulated plates with the inside coatings of the Leyden.

1. In the experiments hitherto made, the two wires to be tested have generally been of the same length. When they were of the same material, but of different diameters, the testing elongation showed, as was to be expected, that the test wire in the branch containing the thicker wire was more heated in the test wire in the other branch. In a continuation of the experiments we hope to compare hollow and tubular wires of the same external diameter, and same length and same material.

2. With wires of different non-magnetic material—for example, copper and platenoid—of the same length, but of very different diameters, so as to have the same resistances, the testing elongations were very nearly equal.

3. In one series of experiments the tested conductors were two bare copper wires, each ·16 cm. diameter, 9 metres long, and resistance ·085 ohm, which, it will be observed, is very small in comparison with the 12 ohms in each of the platinum test wires. One of the copper wires was coiled in a uniform helix of 40 turns on a glass tube of 7 cm. diameter. The length of the helix was 35 cm., and the distance from centre to centre of neighbouring turns therefore $\frac{7}{8}$ cm. The middle of the other copper wire was hung by silk thread from the ceiling, and the two halves passed down through the air to the points of junction in the circuit. The elongation of the test wire in this channel was more than twice as much as that of the test wire in the channel, of which the helix was part.

4. One hundred and seventy-one varnished pieces of straight soft iron wire were placed within the glass tube, which was as many as it could take. This made the testing elongation 10 times as great in the other channel.

5. The last comparison which we have made has been between iron wire and platinoid wire conductors. The length of each was 502·5 cm. The diameter of the iron wire was ·034 cm., and its resistance 6·83 ohms. The diameter of the platinoid wire was ·058 cm., and its resistance 6·82 ohms. Each of these wires was supported by a silk thread from the ceiling, attached to its middle (as in 3 and 4 for one of the tested conductors). Fourteen experiments were made, seven with the test wires interchanged relatively to the branches in which they were placed for the first seven. The following table shows the means of the results thus obtained, with details regarding the electrostatic capacities of the Leyden jars and the voltages concerned in the results.

In each case four Leyden jars, connected to make virtually one of capacity ·02742 microfarad, were charged up to 9,000 volts, and discharged through divided channels. The energy therefore in the Leyden before discharge was $11·105 \times 10^6$ ergs. In each of the first three cases 1,450 volts were found remaining in the jars after discharge; in each of the last four 1,400.

Energy remaining in Leyden after discharge.	Energy used.	Elongation of testing wires in cms.			
		In channel containing platinoid.	means.	In channel containing iron.	means.
·29 × 10^6 ergs.	$10·82 \times 10^6$ ergs.	·01794	·01829	·01226	·01239
"	"	·01861		·01247	
"	"	·01832		·01244	
·27 × 10^6 ergs.	$10·84 \times 10^6$ ergs.	·01823	·01836	·01276	·01261
"	"	·01828		·01280	
"	"	·01828		·01244	
"	"	·01865		·01244	

The mode of measuring the elongation of the test wires was, as may be understood from the preceding description, somewhat crude, but it is reassuring to see that the mean results in the cases of 10·82 and 10·84 megalergs of energy used are so nearly equal. The ratios for the two circuits are, in the two cases, respectively 1·48 and 1·46. The conclusion that the heating effect in the test wire in series with the platinoid wire is nearly one and a half times as great as that of the test wire in series with the iron is certainly interesting, not only in itself, but in relation to Prof. Oliver Lodge's exceedingly interesting and instructive experiments on alternative paths for the discharge of Leyden jars, described in his book on "Lightning Conductors and Lightning Guards," which were not decisive in showing any general superiority of copper over iron of the same steady ohmic resistance, but even showed, in some cases, a seeming superiority of the iron for efficiency in the discharge of a Leyden jar. Our result is quite such as might have been expected from experiments made eight years ago by Lord Rayleigh, and described in his paper "On the Self-Induction and Resistance of Compound Conductors."*

CONTINUOUS CURRENT DISTRIBUTION OF ELECTRICITY AT HIGH VOLTAGE:

Being a Description of the Lighting of the City of Oxford.

By Thomas Parker.

(*Read before Section G, August 13th.*)

The site determined upon for the central station is situated on the banks of the Isis, some 1,500 yards from the centre of the area to be first lighted. This necessitated the use of a high-tension supply, and after due consideration, the high-tension continuous current system

* *Phil. Mag.*, Vol. xxii., 1886, p. 469.

was preferred to the alternating, as giving the decided advantages of being able to supply the light day loads with batteries when the main generating station is shut down, and also of being able to use efficient motors. At the central station, high-tension continuous currents are generated at an E.M.F. of 1,050 to 1,100 volts. The current is conveyed to a central switch station situated in Broad Street, by means of two pairs of cables, each having a sectional area of ·2 square inches, thoroughly insulated with India-rubber, vulcanised, and strongly braided. The insulation resistance is 3,000 megohms per statute mile; these cables are drawn into iron pipes. The cables are led to double-pole switches in the switch station, and by means of omnibus bars to the transformer boards. Each of these boards has an ammeter, a double-pole patent automatic cut-out, combined with a switch and a multiple contact regulating switch and resistance in the main primary circuit in series with the transformer armature. These are mounted on slate bases. Above each board is a Pilot voltmeter, connected to the point in the secondary network at which the low-tension armatures supply current for distribution. For the complete control of the whole of the transformers supplying the district, only one man is required in the switch station; if the nature of the district had allowed of the central station being placed within the city, all the switching would be done by the engineer-on-watch at the generating station. The Pilot voltmeters in the switch station show the pressure on the network, and as the load increases in any district, indicate when to put on an additional motor-generator. In putting a fresh motor-generator on to the network, the first operation is to close the double-pole automatic cut-out which conveys the high-tension current to the transformer. The current is taken through a resistance of about 40 ohms before leaving the station, and passes into the high-tension side of armature of the motor-generator, and excites the field by a few turns of series wire on the magnets. The brushes on both commutators are kept permanently down, and the machine begins to revolve as a motor, the shunt which is connected across the low-tension armature rapidly energising the field magnets to the full saturation, so that the speed does not exceed the normal 550 revolutions. So soon as the machine is fully excited, the high pressure primary current will have fallen to about 3½ ampères, which is the actual in-put with no current on the secondary. The transformer is now running "light," and the secondary E.M.F. can be adjusted by means of the multiple contact switch and resistance coils abovementioned. When this corresponds to the pressure at that time on the network, connection is made with the secondary armature and the mains. This is accomplished at the central switch station by momentarily opening and closing a small switch, which, short-circuiting the voltmeter, causes an increase of current to flow through a magnetic switch placed in the sub-station. The latter switch has its magnet coil always in circuit with the pilot voltmeter, the small current constantly passing being insufficient to affect the switch. When the voltmeter cable is short-circuited at the switch station, the resistance is so arranged that the full current required to operate the switch is allowed to pass through the wires, and causes the magnet to ascend and actuate a switch to complete the circuit between the low-tension armature and mains. On the switch at the switch station being again broken, the magnet drops, and revolves a cam wheel to a position suitable for breaking the circuit, when the magnet is again energised from the switch station. The voltmeter now reads as before, having been only momentarily short-circuited, the one wire doing duty to the voltmeter, and operating the sub-station. The E.M.F. on the pilot voltmeter is kept constant by means of the regulating resistances in the primary circuit, as before explained. When the load has fallen again, which is indicated by the pilot voltmeter, the transformer is disconnected in a similar manner. First of all the resistance is inserted until the ammeter shows that no current is being supplied from the transformer to the network, then the switch short-circuiting the voltmeter is again made and broken, causing, as before, ¼th of a revolution of the cam wheel, which this time allows a spring to pull out the contact piece which joins the transformer to the mains. As the switch is not, under ordinary circumstances, broken while there is current passing, there is no sparking at the brushes, and consequently the switch requires no attention. A cut-out arrangement is provided, so that in the event of too much current being supplied from the transformers to the mains, a magnet is raised, knocking the cam wheel round and breaking circuit, but leaving the switch ready to be worked again from the switch station. This cut-out also protects the transformer in event of the machine being placed on the circuit without the E.M.F. being properly adjusted, or in case a hot bearing should cause the transformer to pull up. Each transformer consists of an ordinary horse-shoe magnet with a single armature, the secondary winding being placed on the top of the primary, with a commutator at each end. The brushes are always left down, and as the action of the two windings neutralise each other, no alteration of lead is required for change of load. The bearings are fitted with automatic oil pumps, which, drawing their supply of oil from a chamber contained in the dynamo pedestal, use the same oil again and again, and transformers have been working for a period of six months without changing the oil.

The low tension distributing network consists of armoured cables. The cables consist of two sizes, *i.e.*, ½-inch and ¼-inch section, and are laid in a trench under the footpaths, being provided with disconnecting branch boxes, so that any section or street can be cut out. Here again, owing to the use of continuous currents, a saving is effected, there being no loss due to induction, and a pair of steel armoured flexible cables can be used. This makes a difference in the cost and trouble of connecting up new consumers; also as the cables themselves are flexible, a good deal of trouble and expense is saved when first they are laid where gas and water pipes are found at varying depths beneath the footpaths. The high-tension feeders to the transformers are a similar class of cable to the trunk mains, being drawn into iron pipes. At the present time there are seven transformers in use, and five sub-stations. At some sub-stations two transformers are used; it was thought advisable to keep to one standard size. At the switch station at Broad Street there are installed two transformers and a battery capable of discharging at the rate of 120 ampères for eight hours. This battery will supply about one-twentieth of the load that the present station was designed for, and is capable of taking the load from about 1 o'clock in the morning until half an hour after sunset. The battery is charged by a small motor generator, which gives an output of 33 volts, 100 ampères, from the secondary armature, being supplied from the network at an E.M.F. of 103 volts on the primary. The 33 volts obtained from the secondary armature is put in series with the network, giving a total E.M.F. of 136 volts, which is sufficient to charge the cells; this may appear to be an inefficient method of charging cells, but only a small portion of the charging energy passes through the machine, and the total efficiency is 92·5 per cent; this is more economical than charging from the network with a regulating resistance, besides saving the trouble of having to arrange the cells differently for charging and discharging. The Broad Street switch station is also the offices of the company. The generating station is a brick building, some 80 feet long by 60 feet wide, built by Messrs. Kingerley, of Oxford, under the supervision of Mr. A. P. Brevitt, Wolverhampton, architect. The two ends are only temporarily built in to allow for extension. In the boiler house, which is divided from the engine house by a party wall, are placed three steel locomotive multitubular boilers, made by Messrs. McLaren, of Leeds; these are constructed for a working pressure of 160 lbs. per square inch, and have proved themselves to be thoroughly satisfactory. A Green's fuel economiser is also fixed in the main flue, having 192 tubes 4½ inches diameter by 9 feet long. The engine room is built in two spans, the engines being placed in the one next to the boiler house, and the dynamos, which are driven by belts, are put on the opposite side, well away from dampness or dirt coming from engines, and are electrically insulated from them. At the present time three inverted triple expansion surface condensing engines are at work; these are made by Messrs. McLaren, of Leeds, and each have cylinders 9 inches, 14½ inches, and 22½ inches diameter, with 24-inch stroke. The high pressure and intermediate cylinders are steam jacketed, and drain through a steam trap into the hot well; each engine has automatic expansion gear, and runs at 125 revolutions per minute. At some exhaustive tests made in Leeds, the following figures of the boilers and engines combined were obtained:—

	Jackets not in use.	Jackets in use.
Total B.H.P.	... 112·8	... 106·85
Water per B.H.P. per hour	... 17·67 lbs.	... 15·513 lbs.
Coal " " "	... 1·767 "	... 1·534 "

These figures show remarkably economical results; they have been obtained, also, in practice, and conduce to the low coal consumption obtained per Board of Trade unit metered.

The three Elwell-Parker dynamos made by the Electric Construction Corporation, Limited, have an output of 1,100 volts, and 80 ampères at a speed of 400 revolutions, and are fitted with a third bearing outside the pulley. They are separately excited by independent small dynamos, each driven from a rope pulley keyed on to main generator shaft. The exciters are wound to give 135 volts, and are of sufficient capacity to charge a small set of cells which are used for lighting the station, as well as supplying current to a small ½-H.P. motor which drives the economiser scrapers. The main dynamos are connected to a double-pole automatic cut-out and switch combined, by means of which they can be paralleled; this is a very easy matter, as no synchronising arrangement or artificial load is required. From these switches the main omnibus bar is taken to the trunk mains, each of which is controlled by a double-pole switch, so that either pair, or both together, can be used at will. The E.M.F. at the station is measured on a Kelvin electrostatic voltmeter, which is connected across the omnibus bars. The whole plant was started on July 18th, 1892, and has run continuously since then, giving every satisfaction.

By the figures hereafter given it will be seen that owing to the use of continuous currents, and the contingent advantage of being able to shut down the station for such long periods, the Oxford system is in the front rank in adaptability and economy of working. The efficiency of the transformers varies from 87 per cent. at half load to 92 per cent. at full load, and as it should not be necessary to work a transformer with less than half load, the efficiency should not be less than 87 per cent. In actual practice at Oxford, as the consumers are somewhat scattered and few, it is necessary to run the transformers at less than half-load during a portion of the time, which has somewhat reduced the efficiency. No doubt during the next few years the gaps in the district will be filled up, and then the all-round efficiency will be increased.

The figures for the year from July 1st, 1893, to June 30th, 1894, inclusive, show that the total efficiency of the system was 62·6 per cent., the Board of Trade units generated being 195,022, and the total units metered 122,081, of which 18,303 were supplied for public lighting. There were also an additional 2,019 units used at the switch station and sub-stations. Out of the 195,022 units generated, 149,668 units were obtained from the secondary of the transformers, giving an all-round efficiency for the transformers of 76·7 per cent., which includes all losses in mains and resistances. Out of the 149,668 units supplied by the transformers, 114,721 units were supplied to consumers, and 34,947 units for charging the battery. The total number of units obtained from the battery was 16,357, which makes the battery efficiency of the year 43·9 per cent. Adding the 16,357 units obtained from the battery to the 114,721 units obtained from the transformers, we get a total output of 131,077 units supplied to circuits. The total metered was 124,101, including those used at switch station, so that there remains 6,976 units unaccounted for, or not quite 5½ per cent.; as the current is supplied at 102 volts, and metered at 100, 2 per cent. is thus accounted for, and the rest is probably due to error in instruments or observation of readings, these

having been taken half-hourly throughout the year, the tendency being naturally to over-read than to under-read the instruments. In all the following figures of cost the units metered have been taken as the basis, leaving out as losses the difference of supplying at 102 volts and metering at 100, and also the current used at the works. The actual coal used during the 12 months was 6·43 lbs. per unit sold. During this period the cost of coal, which was best Welsh, averaged 21s. 10d. per ton, working out to ·752 pence per Board of Trade unit. The cost of coal increased during the coal strike, and still remains high. In comparing this cost with that of other stations, due consideration must be given to the total out-put being only just over 100,000 units, whereas Newcastle and Bradford, which, I believe, are the only stations which spend less per unit on their coal, have a total out-put in 1893 of 360,000 and 480,000 units respectively.

The total number of 8-C.P. 35-watt lamps installed on June 30th, 1894, was 7,774, whereas on July 1st, 1893, there were only 5,060 connected to the mains. As in Oxford the colleges form a large portion of the supply, the term time is the only part of the year when a load can be obtained, so that last year only for about eight weeks was even half the plant required at the maximum load, and the system has to be very elastic to cover it and show good results. The total cost of all generating expenses, including all rates, taxes, and rent, was 3·715d. per unit delivered to consumers. The cost is divided up as follows:—

Coal	·752d.
Oil, waste, water, and engine-room stores	·042d.
Wages, including engineer	1·221d.
Repairs and maintenance of public lamps	·366d.
Repairs and maintenance	·907d.
Rents, rates, and taxes	·427d.
	3·715d.

Management and office expenses cost 1·534d. per unit, making a total of 5·249d.

In the above figures due regard must be paid to the fact that for the greater part of the year only about half load for one engine was ever required, so that more than double the output could have been supplied with slight increase of wages, and little extra on maintenance. Thus, with double the output, the figure would have been somewhat as follows:—

Coal	·752d.
Oil, &c....	·042d.
Wages	·650d.
Repairs	·450d.
Public lamps	·183d.
Rents, &c.	·214d.
Total	2·291d.

which figures are good with so low an output as 240,000 units.

The revenue for the year from lighting was £3,715 8s. 2d., giving 10s. 11d. per 35 watt lamp installed, the number of units used being 18·2 per lamp throughout the year, and the average price obtained 7·3d. per unit.

The load factor at Oxford only works out to 5·93 per cent. By the expression "load factor" is meant the ratio of the units sold to the units that could be sold, with all the lamps always on, viz.:—

$$\frac{\text{Meters watt-hours} \times 100.}{\text{Mean watts installed} \times \text{number of hours in the year.}}$$

I have to thank Mr. J. H. Woodward, A.M.I.C.E., and Mr. E. S. G. Rees for their assistance in the designing of the system; also Mr. J. H. McLean, who has put down the plant, under my direction, for the Electric Construction Company, and is now engineer to the Oxford Company.

SIGNALLING THROUGH SPACE.

By W. H. Preece, C.B., F.R.S., &c.

(*Read before Section G, August 13th.*)

Whenever an electric current rises or falls in a circuit another current is simultaneously induced in every neighbouring conductor, if it form part of a circuit and be separated from the former by some insulating medium or dielectric, such as air. This secondary current flows only during the period of rise or of fall of the primary current.

Hence, if the primary current rises, falls, or changes its direction regularly and repeatedly a given number of times per second, the induced secondary currents will alternate with the same regularity and frequency. The intensity of these secondary or induced currents, among other things, will depend upon the character, form, and direction of the circuits, and upon the distance which separates them from each other. That such secondary currents, or electro-magnetic disturbances, as they are called, existed, has, of course, been known since the days of Faraday; but that they could be observed, measured, and utilised at a distance of some miles from the primary circuit, was not suspected before the introduction of that marvellously sensitive instrument, the telephone.

When these disturbances are rhythmic, musical sounds are produced in telephones fixed in the secondary circuits, but when they are irregular, unpleasant noises alone are heard. If the sounds are preconcerted and directed, like the dots and dashes of the Morse code, then telegraphy is possible, and we have a means of signalling through space without wires. The distance to which we can signal is limited only by the distance to which these electro-magnetic disturbances, in their transit through space, retain sufficient energy to actuate our apparatus. The ether is supposed to be the real medium of transmission, and not the air. The disturbances through the ether take the form of undulations or waves, and in character they are similar to those radiations which at other frequencies give us heat, light, and photography. They move with the same velocity; they are subject to the same operations of reflection and refraction; and they differ only in the number excited per second.

Thus, to deal with the subject of signalling through space, we must have a primary conductor, in which vibratory or alternating electric currents can be excited at will. They must alternate with a frequency that will pleasantly affect the ear—say about 600 per second. They must be manipulated so as to produce preconcerted signals. The primary circuit must be freely exposed in the ether; and the secondary circuit, which it is desired to excite, must not be screened from the primary by means of magnetic or conducting matter. The object of this lengthened inquiry has been to determine the best form of primary and secondary circuit, the function performed by the earth as a part of the circuit, and the distance to which communication is possible with the ordinary practical means at our disposal.

The telephone as an instrument of precision is scarcely sufficiently appreciated. The ear can be trained by its aid to measure graduations of sound as accurately as the eye determines the calibrations of engraved scales. In Hughes's induction balance we have a well-determined absolute zero of silence, and there are many well-defined nodes of sound which may be taken as fiducial points in a telephonic scale. The limit of speech where articulate sounds cease to be comprehensible is one, the limit of Morse signals where telegraphic reading becomes impossible is another. It is quite easy to determine the similar intensity of two sounds, as in photometry the eye determines the similar intensity of two illuminations. The ear, however, requires to be educated, and it is subject to fatigue; but when properly trained, and when assisted by the telephone, it can be used to observe effects with as much reliability as the eye.

My attention was first directed to the subject in 1884. In 1886 I brought it before this Association at Birmingham, and again at Manchester in 1887. In August, 1893, I reviewed, before the Electrical Congress at Chicago, the whole of my previous nine years' work. Much experimental work has been done during the past 12 months. In 1884 electro-magnetic disturbances were detected between telegraph circuits and telephone circuits 80 feet apart, the former in the streets underground in London, and the latter on the housetops; but in 1885 these effects were perceptible between parallel lines of telegraph 10¼ miles apart. The permeability of stone walls and buildings to electric waves was shown by Henry in 1842, when the discharges of a Leyden jar in the top floor of his house induced sparks in a circuit in the cellar. Sonorous vibrations were reproduced in a telephone circuit in the basement of the G.P.O. in 1886 by the induction of a primary circuit, excited by the voice in the upper corridor, 80 feet away. Speech was found possible between insulated coils of wire a quarter of a mile apart. Telegrams in 1893 were transmitted across a distance of 3·1 miles on the Bristol Channel. Regular communication was held last winter across Loch Ness, a distance of 1¼ miles, and recently at a much greater distance, between Arran and Kintyre, across Kilbrannan Sound. Across Loch Ness speech was maintained.

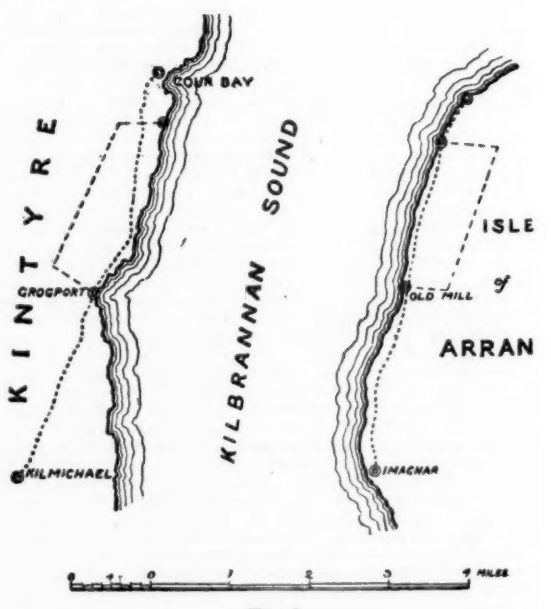


Fig. 1.

But this is not all. There is every reason to believe that we have detected distinct disturbances in our telegraphic circuits, due to great electrical storms in the sun's photosphere, 92,000,000 miles away.

The fact that these signals across space are effects of induction, transmitted through the air or the ether as the dielectric, is beyond the region of doubt, for they were produced between isolated and insulated coils, each forming a complete metallic circuit; but the part played by the earth at short distances, when the earth was used to complete the circuit, was not so clear. Very exhaustive experiments

were made on the sands in the Conway estuary in 1893, and again at Frodsham, on the estuary of the Dee, in 1894. These experiments were conducted for me by Mr. Gavey and Mr. H. R. Kempe. Further experiments were made by Mr. Gavey and Mr. Cooper on opposite sides of Loch Ness, a distance of 1¼ miles, and between the Island of Arran and Kintyre, where parallel wires, four and five miles apart, were available for use.

In the Conway estuary and at Frodsham, squares and rectangles were formed of insulated wires, and numerous measurements were made, both with reflecting galvanometers and with telephones, of the effects due to varying currents in the primaries, and at varying distances between these and the secondaries.

At Loch Ness two parallel wires on opposite sides of the Loch were taken. Between Arran and Kintyre (fig. 1) two parallel lines on opposite sides of the Sound, and four miles apart, were taken; and, in addition, two gutta-percha wires were laid along each coast at a height of 500 feet above the sea level, and five miles apart horizontally.

The general results and the conclusions arrived at may be briefly summed up as follows:—

The earth acts simply as a conductor, and *per se* it is a very poor conductor, deriving its conducting property principally, and often solely, from the moisture it contains. On the other hand the resistance of the "earth" between the two earth plates of a good circuit is practically nothing. Hence it follows that the mass of earth which forms the return portion of a circuit must be very great, for we know by Ohm's law that the resistance of a circuit increases with its specific resistance and length, and diminishes with its sectional area. Now, if the material forming the "earth" portion of the circuit were, like the sea, homogeneous, the current flow below the earth plates would follow innumerable but definite stream lines, which, if traced and plotted out, would form a hemispheroid. These lines of current have been traced and measured. A horizontal plan on the surface of the earth is of the form illustrated in fig. 2, while a vertical section through the earth is of the form shown in fig. 3.

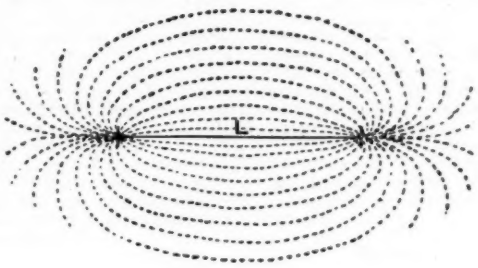


Fig. 2.

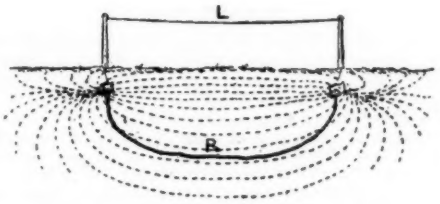


Fig. 3.

With earth plates 1,200 yards apart these currents have been found on the surface at a distance of half a mile behind each plate; and, in a line joining the two transversely, they are evident at a similar distance at right angles to this line.

Now, this hemispheroidal mass could be replaced electrically by a resultant conductor (R, fig. 3) of a definite form and position, and, in considering the inductive action between two circuits having earth returns, it is necessary to estimate the position of this imaginary conductor. This was the object of the experiments at Frodsham.

If the material of the earth be variable and dry the hemispheroid must become very much deformed and the section very irregular, the lines of flow must spread out further, but the principle is the same, and there must be a resultant return. The general result of the experiments at Frodsham indicate that the depth of the resultant earth was 300 feet, while those at Conway are comparable with a depth of 350 feet.* In the case of Frodsham the primary coil had a length of 300 feet, while at Conway the length was 1,320 feet. At Loch Ness, and between Arran and Kintyre, where the parallel lines varied from two to four miles, the calculated depth was found to be about 900 feet. The depth of this resultant must, therefore, increase with the distance separating the earth plates, and this renders it possible to communicate by induction from parallel wires over much longer distances than would otherwise be possible.

The first and obvious mode of communicating across space is by means of coils of wire opposed to each other in the way familiar to us through the researches of Henry and Faraday. All my illustrations of the principles involved in effecting this object have consisted in opposing two similar coils of wire having many turns, the one coil forming the primary current and the other coil the secondary circuit.

Vibratory or alternating currents of considerable frequency were sent through the primary circuit, and the induced secondary currents were detected by the sound or note they made on a telephone fixed in the secondary circuit.

The distance to which the effective field formed by a coil extends increases with the diameter of the coil more than with the number of turns of wire upon it. A single wire stretched across the surface of the earth, forming part of a circuit completed by the earth, is a single coil, of which the lower part is formed by the resultant earth return, and the distance to which its influence extends depends upon the height of the wire above the ground, and the depth of this resultant earth.

In establishing communication by means of induction there are three dispositions of circuit available, viz.: (*a*) single parallel wires to earth at each extremity; (*b*) parallel coils of one or more turns; (*c*) coils of one or more turns placed horizontally and in the same plane.

The best practical results are obtained with the first arrangement, more especially if the conformation of the earth admits of the wires being carried to a considerable height above the sea, whilst the earth plates are at the sea level. By adopting this course the size of the coil is practically enlarged, and even if it be necessary to increase the distance between the parallel wires to effect this object the result is still more beneficial. In a single wire circuit we have the full effect of electrostatic and electro-magnetic induction, as well as the benefit of any earth conduction, but in closed coils we have only the electro-magnetic effects to utilise.

In one experiment, two wires of a definite length were first made up into two coils forming metallic circuits, then uncoiled and joined up as straight lines opposed to each other, with the circuit completed by earth. The inductive effects, and the distance between which they were observable, was very many times greater with the latter than with the former arrangement.

Incidentally some extremely interesting effects of electro-magnetic resonance were observed during the experiments in Arran. A metallic circuit was formed partly of the insulated wire 500 feet above the sea level, and partly of an ordinary line wire, the rectangle being two miles long and 500 feet high. Wires on neighbouring poles, at right angles to the shorter side of the rectangle, *although disconnected at both ends*, took up the vibrations, and it was possible to read all that was signalled on a telephone placed midway in the disconnected circuit.

I have not succeeded in determining satisfactorily the general law which regulates the distance to which one can speak, and I scarcely hope to do so. There are so many disturbing elements introduced, geological as well as electrical. In practice we have to deal with two complete circuits of unknown shape and in different planes. We have obtained some remarkably concordant and accurate results in one locality, but we have met with equally discordant results in another locality. I fear we are beyond the reach of the mathematician. In the appendix I have shown the formulæ that gave the most reliable results.

The mechanism of the mode of signalling across space is not difficult to follow. Its analogue is a flash of light seen at a distance. Energy is expended, say, in a lighthouse on some dangerous rock, or in a gun firing some warning signal, or in a bonfire on some mountain top. The energy assumes the luminous form exciting the ether to undulate with a frequency of many millions per second, which, acting upon the retina of the eye, produce the sensation called light. The burning of the oil lamp of the lighthouse is the primary source of energy; the rapid undulations of the ether propagated in straight lines at a velocity of 186,000 miles per second are the radiations, transmitting this energy in a wave form to the distant ship; the eye is the apparatus which transforms the energy of the light waves into a form which excites consciousness in the brain.

In our electrical experiments the primary energy is in the current form, the comparatively few hundred alternations per second excite waves in the ether of a few hundreds per second only. But these oscillations of the ether or electric waves are of the same character as those of light, they move with the same velocity, and when they fall on a sympathetic secondary conductor, they excite in that conductor currents of electricity of the same frequency; and if a telephone be inserted in that circuit and applied to the ear, sounds and musical notes are distinctly heard, which, by preconcerted measures, such as the use of the Morse code, can be utilised for the transmission of messages. Thus messages were sent across the Bristol Channel between Penarth and Flat Holm Island, 3·1 miles away. Speech was maintained in the Highlands across Loch Ness, 1¼ mile broad, and telegrams were transmitted from Kintyre to Arran, across distances of four and five miles, and thus we could readily communicate between England and France, or between outlying islands and the shore, when the conditions admit of the erection of the necessary circuits.

A somewhat fascinating branch of this subject is the possibility of signalling across planetary space. Signalling between one planet and another is merely a question of degree. Magnetic storms and earth currents have some intimate connection with the sun, although Lord Kelvin has questioned the reality of the fact. The great storms and sun spots of March 30 and 31st, 1894, were accompanied by very marked and peculiar sounds in telephones inserted in our long telegraph circuits (*vide* Appendix II.). The storm of July 20th was not so distinguished. Strange, mysterious, weirdlike sounds are frequently heard on long lines of telegraph in the calm stillness of the night, but whether due to terrestrial or to cosmic causes remains to be discovered. The sun's photosphere when disturbed by spots may be subject to violent electrical storms and those vast clouds of incandescent hydrogen that flame up with terrible velocity may excite electrical oscillations through etherial space of such a frequency as to influence our terrestrial circuits. We may thus hear on earth the electric storms of the sun. But this is mere speculation, and the

* These figures are obtained from the use of the formula:

$$Q = K\left\{\log\left(\frac{D^2}{d^2}+l\right)\right\},$$

which is given in Appendix I.

evidence before us at present is not sufficient to justify positive deduction. We shall continue to watch and record, and it is hoped that observers in other parts of the world will assist by making use of the telephones and telegraph lines at their disposal.

The practicability of this method of effecting communication is now solved, but the subject possesses great scientific interest from the views it imparts of the mechanical character of electrical waves, of the molecular theory of electricity and of the great distances at which electro-magnetic disturbances are perceptible.

Appendix I.

The following are the formulæ on which the foregoing calculations are based:—

Let A, B (fig. 4) be an infinitely long wire, and c and d be two wires forming parallel sides of a rectangular circuit, E, F, G, H; then,

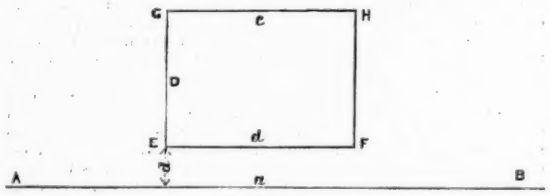


Fig. 4.

if a current be set up in A, B, the lines of force cutting E, F, and G, H, will cause a momentary current to be set up in the rectangle, so that

$$Q = K\{\log (D + d) - \log d\} = K \log \frac{D + d}{d}$$

where Q is the quantity induced.

K is a constant depending on the length of the sides G H, E F, of

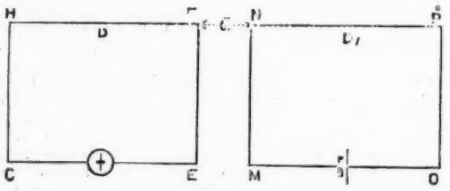


Fig. 5.

the rectangle in centimetres, the current strength in ampères in the wire, A, B, and the total resistance of the rectangle in ohms.

Within certain limits this formula is approximately correct, even if

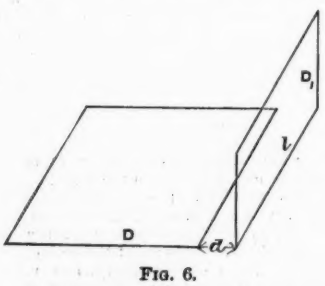


Fig. 6.

the wire, A, B, is not infinitely long, but makes one face of a second rectangle, similar in form to the induced rectangle, E, F, G, H, and set either in the same plane with, or at right angles to, the first rectangle;

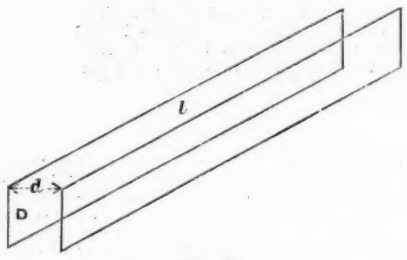


Fig. 7.

but in such cases the formula has to be corrected to allow for the influence of the second face of the inducing rectangle as follows:—

With two rectangles in the same plane (fig. 5), the total effect produced by the two faces, M, N, O, P, of the inducing rectangle is

$$Q_1 = K\left\{\log \frac{D + d}{d} - \log \frac{D_1 + d + D}{D_1 + d}\right\}$$

If the two rectangles are at right angles to each other (fig. 6), and l is large compared with D, then the formula becomes

$$Q_2 = K\left\{\log \frac{D + d}{d} - \tfrac{1}{2} \log \frac{D_1^2 + (D + d)^2}{D_1^2 + d^2}\right\}.$$

Again, if the two rectangles are parallel and equal (fig. 7) and l is large compared with D, then

$$Q_3 = K\left\{\log \left(\frac{D^2}{d^2} + l\right)\right\}.$$

These formulæ take into account the effects on the wires in the secondaries which are parallel to the primaries, but not the effects of those at right angles to them. The latter oppose the main induced current, so that in practice this current diminishes more rapidly with the distance than the log law indicates. The problem is very intricate, but Mr. Kempe, to whom I am indebted for the formulæ, still hopes to obtain a final and accurate solution.

Appendix II.

The following letter appeared in *Nature*, April 12th, 1894:—

Earth Currents.

The Astronomer Royal was kind enough to show me the permanent photographic records of earth currents during the great magnetic storm on February 20th-21st, and they indicated so unmistakably such rapid and violent alternations, that I supplied our principal relay stations with telephones and with instructions to insert them in circuit whenever they observed indications of disturbances. This happened on March 30th-31st, during the display of the Aurora Borealis. Mr. Donnithorne, in Llanfair P.G., Anglesea, reports:—"At 2 a.m. (Saturday) the telephone receiver was again tried, and then 'twangs' were heard as if stretched wire had been struck, and a kind of whistling sound. The strength of the earth current was 17·7 milliampères." Mr. Miles, in Lowestoft, reports:—"Noise on 408 (Liverpool-Hamburgh) wire seemed like that heard when a fly-wheel is rapidly revolving," and "sounds in telephone appear like heavy carts rumbling in the distance." Mr. Scaife, in Haverfordwest, reports: "March 31st, 2.5 a.m. Earth currents on all wires; wires completely stopped. . . . Peculiar and weird sounds distinctly perceived, some highly-pitched, musical notes, others resembling murmur of waves on a distant beach. . . . The musical sounds would very much resemble those emitted by a number of sirens driven at first slowly, then increased until a 'screech' is produced, then again dying away. Duration of each averaged about 20 seconds." These experienced observers, situated at three distant points, and perfectly acquainted with the ordinary inductive disturbances on telephone circuits, simultaneously observed and independently recorded their own impressions of peculiar sounds exerted in telephones by very rapid alternations or pulsations of currents which accompanied, or were consequent on, sun spots, earth currents, and the Aurora Borealis. W. H. Preece.

G.P.O., *April 9th.*

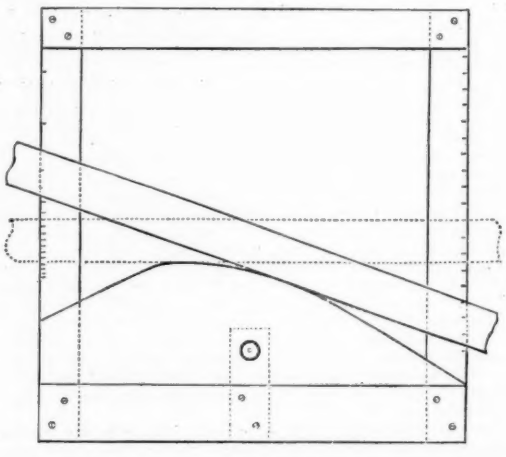
A GRAPHICAL TRANSFORMER.

By A. P. Trotter.

(*Read before Section A, on Saturday, August 11th*, 1894.)

This instrument is intended for the expeditious re-plotting of a curve with transformed ordinates without calculation or scaling. It consists of a rectangular frame and a curved template or cam, and is used in conjuntion with a straight ruler.

Let the scale of one system of ordinates be set off upwards along the edge of one of the perpendiculars, and the scale of the other along the edge of the other perpendicular, but downwards. Join the corresponding points on the scale by straight lines. The envelope of this system of lines may be thus drawn, and to this curve a cam is cut in thin wood or ebonite.



To transform any ordinate, set the frame against a T square, adjusting the edge to the ordinate, and the zero to the zero of the scale. Set a needle at the extremity of the ordinate; bring a straight edge to touch the needle and the cam; prick off a point at the intersection of the straight edge with the other edge of the frame. This point determines the length of the new ordinate.

The illustration represents an instrument provided with a logarithmic cam. With this instrument the product or quotient of two curves can be found by adding or subtracting the logarithms of the ordinates; or the logarithms of a series of observations can be plotted. Cams for other functions can be easily made; but it must be remembered that the action of the instrument is, as it were, arithmetical rather than geometrical, for a cam is useful only with reference to its own scale.

This instrument not only enables transformations of a definite and known character to be made, but is equally applicable for transforming in an empirical manner. The curve drawn by a recording voltmeter or ammeter may thus be re-plotted for estimation of area, or other graphical analysis, without any knowledge of the law of the particular instrument. In other words, a correction can be applied to a curve.

The cams are easy to make, and even if carelessly cut, cannot possibly give rise to cumulative errors. It is convenient to use the upper edge of the ruler instead of the edge which rolls on the cam. The curve must in this case be set out with the ruler, and used with the same ruler, or one of the same width. The rolling of a straight edge on a cam has been used in a photometer, invented by Mr. W. H. Preece and the author,* for the automatic calculation of the squares of the displacements of a lamp.

SOME ADVANTAGES OF ALTERNATE CURRENTS.

By Prof. Silvanus P. Thompson, D.Sc., F.R.S.

(*Read before Section G, August 13th.*)

Amongst electrical engineers there remain a few, chiefly of the old pioneers, who have not grasped the advantages possessed by alternate currents over continuous currents in systems of electric supply. Superstitions still linger that alternate currents are less easy to manage, or are less economical, or are more dangerous, or are less readily measured than continuous currents. There is a special superstition that they cannot drive motors. Such superstitions once set afloat die hard, and sad to relate they are sedulously fostered by a few interested persons who ought to know better. The present paper is intended to point out a few of the more salient advantages attendant on their use, and to add a few points that have recently claimed the writer's consideration, and are not generally known.

It is well known that the economic transmission to a distance of electric energy depends for its success on the use of high voltages or pressures. The reason is that power depends on two factors—current and pressure, and that of these two factors the former current involves some waste in the conductors. If large currents are transmitted at low pressures, there will be either much power wasted as useless heat in the copper conductors, or else the conductors must have such large cross-section that the interest in their prime cost involves a still more serious waste. If small currents are used at high pressure—1,000 volts, 5,000 volts, 10,000 volts, as the case may be—the copper conductors may be small and the interest on their cost a trifling quantity.

Now, this all-important fact to the electrical engineer is absolutely independent of the nature of the current as to whether it is continuous or alternating. The advantage of alternating over continuous currents come in in the circumstance that high pressure cannot be used in houses without being transformed down to low pressure. Hence the system which admits of transformation by a stationary transformer, consisting merely of two coils wound upon a common core, is to be preferred over that requiring running machinery for transformers.

Again, it is an advantage not only for high voltage systems, as distinguished from low, but in all systems, whether high or low, in which currents of considerable magnitude have to be collected and delivered, that there should be no necessity for employing either in the generating plant or in motor any commutators or sliding contacts with their adjustable brushes and the like paraphernalia. The commutator, the indispensable adjunct of the continuous current dynamo and motor, has long been known to be its weakest part, from the engineering point of view. It is complex and costly as compared with other parts. It requires far more attention than any other part of the machine. It undergoes greater wear, and the circumstance that under conditions not far removed from normal it may give rise to serious sparking, is also a disadvantage.

Alternate current generators have no commutators. Those types of alternators in which the armature revolves require, indeed, collecting rings (for sliding contacts) and brushes, a device to which the foregoing remarks on commutators scarcely apply, seeing they need no adjustments nor give rise to sparks. But the type of alternator now coming most in favour do not even require these (except on the exciting circuits, where their disadvantages are *nil*), since in them the high voltage armature parts are stationary. The only part that need revolve are most substantial masses of iron and copper needing no special insulation in their construction, or attention in their operation. To be spared all the troubles arising from commutators and brushes is no small advantage in itself to the central station engineer.

Another advantage of an entirely different character is the greater safety of the alternate currents. With them there is far less likelihood of trouble from leaks in the distributing circuit than if continuous currents were used at the same voltage. This arises from the circumstance that the electrolytic action of the alternate current is so extremely small. If there is a weak point in the insulation of a main or branch conductor where damp can get in to form a path for leakage, the continuous current will find it out and promptly set up chemical corrosion. Corrosion sooner or later ends in setting up an arc, and an outbreak of fire results. The corrosion of water and gas pipes complained of in many districts where a continous current supply is maintained are unknown where alternate currents are used. The danger to life for equal voltages is, I think, now established to be greater with continuous currents than with alternating, as their destructive action on the tissues is greater.

Again, it is no light matter that while in a continuous current supply there is but one way of moderating or regulating the strength of the current which flows to a lamp or motor from the supply mains at a given pressure. There are two modes of regulation possible if the supply be one with alternating current. In the continuous current case, we regulate by introducing resistances, which regulate by wasting power. It is as though when we wanted to put a slow speed on to a power lathe we did it not by changing the gearing, but by putting a grindstone on the same piece of shafting, and slowed it down by grinding something that would waste the power. But in the case of alternate currents, though we may still, if we please, regulate by wasteful means, we have another and non-wasteful way available in regulation—viz., the use of so-called choking coils, or reaction coils, which operate by setting up opposing E.M.Fs. in a purely automatic way—damming back the currents instead of wasting them. The use of choking coils is destined to find a very great increase in services of this kind.

It would be travelling too far from the range of this paper to enter to any great length upon the work that has been done during the past five or six years with combination of two, three, or more alternate currents of different phases. Two-phase and three-phase combinations of alternate currents, using three or four wires for their transmission instead of the ordinary two-wire system of conductors, are now quite well known, and their advantages in special cases are fully recognised. Of course, it will be at once replied that any phase system of currents—that is, a combination of two or three alternate currents, which require three or four wires instead of two, cannot be entirely an advantageous system as compared with simple continuous currents, being more complicated. This is very obvious, and yet the fact remains that with two-phase and three-phase systems of current one can accomplish results which the simpler systems cannot accomplish, and meet conditions which the simpler systems cannot meet. Without attempting any complete exposition of the phasal systems, let one or two points suffice for remark. It has been found essential, or, at least, advantageous, in those districts where continuous currents are used on a large scale, to depart from the sweet simplicity of the two-wire system, and in order to economise in the total cost of copper in the mains to adopt a three-wire, or a four-wire, or even a five-wire distribution, so that sweet simplicity is not always on the side of continuous currents. Again, if a three-wire three-phase system of alternate currents is used, the total weight of copper needed in the conductors (at equal voltage) is less than in the ordinary two-wire system for an equal amount of power, whether that two-wire system be with continuous currents or with alternate currents. The main advantage of three-wire polyphase alternate current systems (whether three-phase or two-phase) is, however, the greater facility that they offer in the handling of motors, since they are more readily made self-starting than is the case where merely single alternate currents are supplied on a two-wire system of distribution.

At the Electrical Congress of Chicago, in the debate on a paper by Mr. Scott, of the Westinghouse Company, on polyphase systems, the writer expressed the opinion that while a polyphase system was adapted to the case of the transmission of power from a single generator to a single motor, in the generality of cases in which the power was to be not only transmitted, but distributed to a number of motors at independent points, greater simplicity of the simple alternating current would render it preferable now that self-starting motors were in the market. Bearing, however, in mind the advantages to be

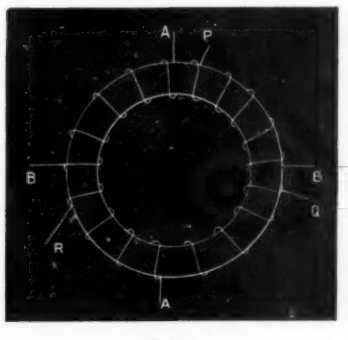


Fig. 1.

derived in the possibility of using two and three-phase motors, the author gave considerable thought during the winter to the problem of transformation, and particularly to the question whether it might not be possible to transform alternating currents from two-phase to three-phase, or from either of these to single-phase, or *vice versa*. No mode of doing this was known save by the combination of motor generators as running machines. As one result of his cogitations, he found that such transformation might very readily be effected by stationary transformers, or in the least easy case by stationary transformers with a revolving iron core. The simplest case—that of transforming three-phase currents into two-phase (or *vice versa*)—involved no moving parts, being effected by using a ring coil (or its magnetic equivalent) with connection made appropriately. For example: if a Gramme ring is connected, as shown in fig. 1, to a two-phase system with 100 volts between A, A, and 100 volts in quadrature between B, B, a three-phase set of alternate currents may be

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* *Proc.* Inst. Civ. Eng., Vol. cx., p. 81.

taken off from the same winding at three equidistant points, P, Q, R, at pressure of 66 volts between each of the three wires. The magnetic field across the coil revolves, and it is preferable to provide a laminated core to complete the magnetic circuit. Such a core may be stationary, or may revolve. A simple ring transformed like the above (without revolving coil) was shown by the author at his lecture on the transformations of electric currents, at the Royal Institution on February 23rd, 1894. It is of some interest to note that on March 7th Mr. Scott read an elaborate paper to the American Institution of Electrical Engineers, in which he gave an independent solution to the very same problem, using two sets of winding (instead of one) but working out in detail many possible applications. It is no exaggeration to say that an electrical engineer starting, let us say with three-phase alternate currents as the method of supply, is in a position to furnish any customer who may desire either two-phase currents or single-phase currents with what he desires, by merely putting in a small appropriately connected transformer. Another advantage, about which even electrical engineers are as yet almost wholly unenlightened, arises in the application of alternate currents to electro-magnets. Great as have been the services of electro-magnets as used with continuous currents, since their invention in 1825, they are destined to fulfil wider services than ever in the practical problems of an electro-mechanical nature now that their properties, when supplied with alternate currents, are becoming known. In 1887, Prof. Elihu Thomson discovered a number of singular properties of alternate current magnets in producing repulsion of copper discs, and rotation of cylinders and balls by reason of the eddy currents induced in them. During the past winter the author has been studying the design, construction, and properties of alternate current magnets, and recently, in conjunction with his assistant, Mr. Miles Walker, read a paper on the subject before the Physical Society of London. A few words on this topic will emphasise the advantages offered by alternate currents in this application. It has long been known that the magnetic forces of a magnet fall off very rapidly at small distances from their poles. For steel magnets in those cases in which the poles can be considered as points, the force falls off inversely as the square of the distance, other things being equal. In the case of soft-iron electro-magnets operated by continuous currents, the pull on their armatures falls off much more rapidly than this. The forces when in contact may be relatively enormous, and yet the magnet may have no range of attraction worthy of mention. A pull of 150 lbs. in contact may dwindle to a few ounces at a distance of a couple of inches.

But with alternate currents supplied at constant voltage from the mains, the author finds all this to be different with a properly designed and well-constructed electro-magnet, the pull on its armature can be kept fairly constant over a considerable range. Nay, in some cases can be caused to be greater at a distance than when near. For example, the author has lately had an alternate current magnet constructed for him by Mr. Walker, the pull of which, when excited at 50 volts, was 8 ozs. when the armature was closely in contact with the core; but which exercised a pull of 32 ozs. when the space between them was 3 inches. This obviously introduces into electric mechanism a new element hitherto undreamed of.

The secret of these things is that in the case of alternate current electro-magnets, the self-induction reaction of the system, and not the mere electric resistance of the wires, is that which governs the flow of current, whereas Ohm's well known law for continuous current is

$$\text{Current} = \frac{\text{Electromotive force}}{\text{Resistance}}, \text{ or } C = \frac{E}{R}.$$

The rule that governs the alternate current in these cases is different, being

$$\text{Current} = \frac{\text{Electromotive force}}{\text{Reactance}}, \text{ or } C = \frac{E}{p\,L},$$

where p is the pulsation of the alternate current, *i.e.*, the number of radians per second in the revolutions of the circle of reference, and L the inductance.

As the armature of the alternate current magnet is withdrawn from the core, the reactance diminishes and more current flows, making the pull greater at a distance instead of less.

Another curious point about alternate current magnets relates to their winding. In the case of electro-magnets supplied with continuous currents, it is well known that the more turns of wire that are wound on the core, the more powerfully is it magnetised. But with alternate current magnets this is not so. There is one particular number of windings for each magnet (generally a small number), for which the magnetism is a maximum, and any additional wire wound on above this number diminishes instead of increasing magnetic power.

Returning from this digression respecting magnets to the general question of the supply of alternate currents, the author has finally to point out one further set of advantages hitherto both neglected and unknown in this country, though known to a few, and actually in use in the United States.

One of the difficulties which beset the distribution of electric currents on the large scale is that of maintaining constant, in all points of the network of conductors, the voltage or pressure at which the current is delivered to the consumers. Between the generating station and the centre of distribution there occurs a loss of pressure (comparable to the loss of head in the case of water-power), and beyond the centre of distribution between it and the points of consumption with house lamps, there is a further drop in the voltage. The former drop in the voltage can be compensated for by due arrangements at the central station, but the further drop between the distribution centre and the consumers' houses, though it may be guessed at and partially compensated by some system of over-compensating at the distribution centre, cannot be accurately compensated. The result is that the consumers' lamps do not receive their supplies of current at an unvarying pressure. Now in the case of continuous current distribution, the only cause for drop in the voltage at distant points is the resistance offered by the conducting wires leading to those points. The drop due to such resistance—or ohmic drop—is proportional to the ohms of resistance, and to the ampères of current. Suppose a group of lamps requiring 20 ampères at some outlying point, the wires to which have a total resistance of only one-tenth of 1 ohm. The drop in voltage, due to the ohmic resistance, will be $20 \times 1\text{-}10 = 2$ volts. The lamps, which ought to receive their currents at a pressure of 100 volts only, return it at 98, and burn dimly in consequence. But in the case of alternating currents there is a second or additional cause of drop, which has hitherto been held to be a serious disadvantage in their use, namely, a drop due to the self-inductive action of the line, reacting and setting up back E.M.Fs., and tending to choke the current. In general, this second or inductive drop is not serious, the mains and branches being arranged concentrically for the purpose of avoiding it as far as possible; but it may become serious when motors as well as lamps are employed upon the circuit, because of the considerable inductive reactions that are set up in the electro-magnet operations of these machines.

Alternate current motors are of many sorts, but may be grouped under two chief classes, the synchronous and asynchronous. Synchronous motors are only those which run at one fixed speed determined for them, irrespective of their load—a speed determined solely by the number of their own poles, and the number of the alternations imposed upon the current by the generating machinery at the station. They must either run in synchronism with the pulsations of the current, or not run at all. The other class, the asynchronous, are mostly polyphase machines, requiring two-phase or three-phase currents to operate them. The phase currents led into a suitable armature, there combine to produce a rotating magnetic field, and in this rotating field masses of iron, or iron carrying closed circuits of copper are set into rotation, being magnetised inductively, and dragged round by the reaction of the eddy currents induced in them. The rotor or rotating part of the asynchronous motor may be regarded as a revolving field magnet, not magnetised by any special exciter or initially, but magnetised only by the eddy currents induced in it. Now if it could spin at the same rate as the revolving magnetic field that surrounds it, there would be no relative motion, no eddy currents, no reactions, and no driving force. It is driven by forces which depend for their existence upon the rotations not being synchronous with the pulsations of the currents in the circuits. Within certain limits it adjusts its speed so that its magnetic slip is proportional to the turning moment which it is called upon to exert.

Now, owing to these necessary reactions, the asynchronous motors produce upon the mains which supply them an inductive drop, and cause the pulsations of current to lag in phase behind the impressed pulsations of voltage. Whereas the ohmic drop is not accompanied by any lag of phase in the current, the inductive drop is so accompanied. Happily, with alternate currents, there exists more than one remedy. It has long been known that a condenser exercises a reaction of another kind, which, though it tends to choke the current, does so not by retarding the phase of the pulsation, but by accelerating it. This precious property has long been known and used in submarine telegraphy to compensate, by the use of condensers, the retardations of the signals. But to apply condensers to systems of alternate current supply for the purpose of counteracting the inductive drop when motors are used would be a rather formidable task; the remedy is too heroic for the malady.

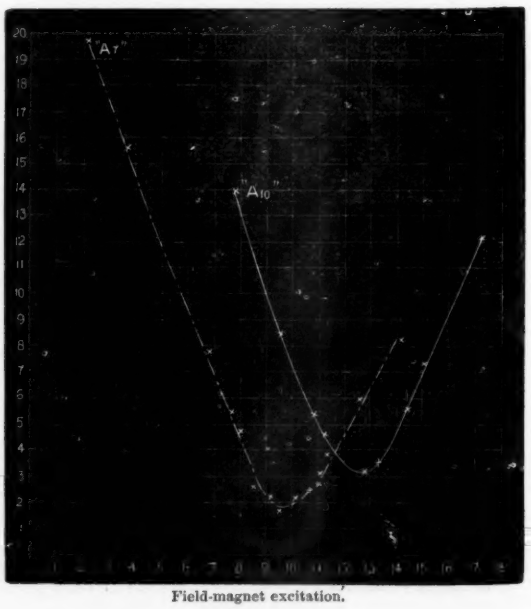

FIG. 2.

A remedy of a different kind is, however, possible, and must before long become general when its advantages are known. To explain it we must return to the subject of synchronous motors, about which

little has been said. It was shown in 1868 by Wilde, and in 1879 by Hopkinson, that two alternate current machines could run together synchronously, one as generator, the other as motor, the one which served as motor adjusting itself so that its pulsation of E.M.F. tended (as in all motors) to oppose those of the impressed E.M.F. In 1884, Dr Hopkinson further predicted that an alternate current machine could run as a motor, even if its mean E.M.F. was higher than that of the circuit, a result verified in practice by Mr. Mordey in 1890. In 1892, Mr. Mordey gave at the Institution of Electrical Engineers some further results of alternate current working, including a very remarkable curve, here reproduced, showing the dependence of the armature current upon the excitation of the field magnets of the motor when loaded with a given load. To this curve and its meaning the author directed attention at the time, and he has given much thought to it. It will be found to be most significant. The curve presents the form of a letter V. The lowest point corresponds to a particular state of things, namely, that the motor having its magnetism excited to a practical degree draws a certain minimum amount of current from the mains, in order to drive its mechanical load at the speed imposed upon it. But to do the same work, drive the same load at the same speed, will take more current from the mains if the excitation of the magnets is either more or less than this particular amount. This seems very strange, but the explanation and its consequences are no less so. The particular stage of excitation which makes the armature current a minimum for the particular load in question, is that stage which corresponds to there being no difference of phase between the pulsation of impressed voltage and those of the resulting current. Suppose, for example, the armature had a resistance of ½ ohm, and that the current was supplied at 100 volts, and that a current of 10 ampères was found the minimum current that would drive the load. It would be found (approximately) that the excitation corresponding to this minimum current would be such as would make the motor work with a back E.M.F. of 95 volts, for thereby Ohm's law $(100 - 95) \div \frac{1}{2} = 10$ ampères. But now suppose the excitation is lessened, the machine acting at the same unalterable speed will generate less than 95 volts. Suppose it drops to 90 volts. Then, if nothing else happened, the current would increase to $(100 - 90) \div \frac{1}{2} = 40$ ampères. But 40 ampères at 90 volts is much more power than 20 ampères at 95 volts, and is more than is wanted for the load. What must happen? The machine is synchronous and cannot—physically cannot—run faster so as to take up this power. It tries to do so, with the result that it shifts the phase of its readings, the current now lagging in phase behind the impressed E.M.F. Choked down, in fact, from the 40 ampères to something more than 20. Choked down, in fact, in such an amount as would, if multiplied by the cosine of the angle of lag, and by the 90 volts comes up to the same product as the original volts and ampères, viz., $95 \times 10 = 950$. The synchronous motor, if *under* excited, acts, then, as a choking coil, producing a reaction drop. But continue the experiment the other way. Suppose the excitation is increased so that the 95 volts becomes 100 volts $(100 - 100) \div \frac{1}{2} = 0$, and there would be no current at all to drive did not an adjustment of phases comes into play. Instead of the current dropping to zero, more current than before now comes into play, and that current has its pulsations in advance of those of the impressed voltage, there being now an angle of *lead* in the phase relations. In other words, the synchronous alternating motor if *over* excited acts as a condenser, and instead of producing a drop in the voltage tends to raise it by compensating the inductive drop, due to self-induction in other parts of the circuit. When the importance of this deduction from Mr. Mordey's curve dawned upon the author, he began to test it upon the mains of the City of London Electric Light Company. But before experiments could be even arranged, he learned that the same conclusions had been arrived at by the officials of the General Electric Company, at Lynn, Massachusetts, and that they had found it in practice to work out favourably. By the courtesy of Mr. W. F. Parshall, one of the engineers of that company, who has been associated for long with Prof. Elihu Thomson, Mr. Steinmitz, and other engineers, the author is able to state the following particulars. They found that in a line where self-induction played the part of a choking coil it did not matter very much whether the voltage needed for driving the current through the line and machine were situated mainly in the generator or in the motor, as the mean voltage in the line was not far from a mean between that of the two. Accordingly, in a three-phase power transmission at Hartford, Conn., of 300-kilowatt output, the motor was arranged to be over-excited. Later, after Mr. Steinmetz had submitted the question to calculations, this feature was introduced into the synchronous motors used in all their recent power transmissions, so that by proportioning the armature reaction and the over excitation to the self-induction likely to arise, the voltages on the circuit remain quite constant regardless of load within the capacity of the machines. In thanking Mr. Parshall for his information, I may add two points for comment. The advantage so to be derived from over excitation have indirectly another advantage, viz., that for single transmission cases the motor and the generator may be designed and constructed as identical machines, instead of the motor being made smaller than the generator. Further, the regulation of the voltages in such a network as that of the City of London Electric Light Company, instead of being made more difficult when motors are much used—as was feared by some engineers—will be more easy, provided the motors are of the over-excited synchronous type. For the acceleration of phase these produce in the current not only tends to compensate for the inductive drop in the mains and transformers, but tends to reach right back. Through the system to the generators in the central station, acting on them as a compound winding would, and assisting them not only to counteract the inductive drop, but also the ohmic drop, both between the consumers' lamps and the distributing points, and also between these points and the generating station.

So manifest is this advantage, that it would seem worth while to erect at one or possibly more points of the network, as remote as possible from the generating station, synchronous motors over excited, to act as condensers in compensating the inductive drop, or in the primary circuit, also to furnish the idle currents for magnetising the transformer primaries.

With such possibilities open in the future for alternate current working, and with such advantages in respect of motive power over continuous current working, it can hardly be doubted that, save in a few special cases, the vast majority of central stations will henceforth be operated by alternate currents.

LEGAL.

Alabaster *v.* Harness.

In the Queen's Bench Division of the High Court on Friday last, Mr Justice Hawkins gave judgment in the case of Alabaster and others *v.* Harness and the Medical Battery Company, Limited. The action was one of maintenance, and was before his Lordship on two previous occasions, the case being first dealt with on the evidence, and afterwards argued on points of law. His Lordship, in giving judgment, said that this was an action for maintenance, brought by the plaintiffs, the proprietors of the Electrical Review, against the defendant, Cornelius Bennett Harness, and the Medical Battery Company, Limited, of which company Mr. Harness was managing director. The Medical Battery Company was incorporated for the purpose of carrying out the treatment of diseases by means of electric and magnetic appliances. They manufactured a belt which was thought suitable for such treatment, and as part of their establishment they founded and maintained an institution called "The Electropathic and Zander Institute," with Mr. Harness as its head. In January, 1892, the plaintiffs published in the Electrical Review an article by way of protest against certain appliances and electric belts which had been publicly exhibited by the company at the Crystal Palace, as being constructed in direct opposition to the most elementary laws of electricity; and in July and September of the same year plaintiffs published other articles against the institution and against Mr. Harness, its president. In respect of these articles the Medical Battery Company brought their action against the present plaintiffs on September 23rd, 1892. The pleadings in that action were completed, but no notice of trial was ever given, and on April 28th, 1893, the action was discontinued. On that same September 23rd another article appeared in the Electrical Review, commenting in very strong and adverse terms upon a report which had recently been written and published by Dr. Tibbits, testifying to the great value of the institution, its apparatus, appliances, and electric belts. The article reflected seriously upon the character and conduct of Dr. Tibbits in connection with that report, and also upon the Zander Institute and its appliances, and the conduct of Mr. Harness as its manager and vendor of the belts bearing his name. In respect of this article, so far as it reflected upon his character and integrity, Dr. Tibbits, on October 1st, 1892, commenced an action for libel, in his own name only, against the present plaintiffs. The action came on for trial before Mr. Justice Mathew on February 15th, 1893, and it resulted in a verdict for the then defendants on the ground of privileged criticism. The costs of this action Dr. Tibbits was unable to pay, and this action was subsequently brought against the now defendants, Mr. Harness, and the Medical Battery Company, to recover the damages sustained by the plaintiffs, upon the ground that the now defendants unlawfully maintained Dr. Tibbits in bringing and prosecuting his action. He should not think it necessary, after the full and exhaustive judgment of Lord Coleridge in Bradlaugh against Newdegate, to occupy much time in considering what in law constituted unlawful maintenance, because he did not understand Mr. Jelf to deny that the defendant did, in fact, maintain Dr. Tibbits's suit; but it was insisted that such maintenance was not unlawful or actionable, inasmuch as he had a common interest with Dr. Tibbit's in bringing and prosecuting the action, or, at least, that he honestly believed, on reasonable grounds, that he had such interest. Whether he had or had not was the question he had to determine. The maintenance charged consisted in Mr. Harness suggesting to Dr. Tibbits to commence his action, in employing a solicitor nominated by him to issue the writ, and in conducting the action at his (the defendant's) sole expense. Although there was no real difficulty in determining what amounted to maintenance, the solution of the question whether it was justified or not would be assisted by directing attention to the definition of unlawful maintenance in "Coke upon Littleton." Lord Coke said it was maintenance "when one maintaineth either side without having any part of the then plea or suit." Hawkins described it as "when one officiously meddles in a suit pending in any such Court which in no way belongs to him by assisting either party with money, or otherwise, in the prosecution or defence of any such suit." (See also "Ratcliffe *v.* Anderson.") In the same book, Hawkins gave the reason on which the law against maintenance was based. Maintenance, he said, was strictly prohibited by the common law as having a manifest tendency to oppression by encouraging and assisting persons to persist in suits which otherwise they would not venture to bring on. Therefore all offenders of this kind were not only liable to pay the cost of maintaining a suit, but could also be convicted as offenders against public justice. This principle was also stated by Lord Abinger in "Prosser against Edmonds: "No encouragement shall be given to litigation by the introduction of parties to enforce writs which others are not disposed to enforce." In considering under what circumstances maintenance could be said to be part of the plea or suit, some assistance might be derived from a few passages in "Hawkins's Pleas of the Crown." It

mentioned exemptions in favour of certain neighbourly acts, acts of charity, and those who maintained suits in which they had a common interest. First as to the neighbourly acts. In Section 9, Hawkins said: "However it seems clear that a man is not to be deemed guilty of an act of maintenance by giving another friendly advice, for it would be extremely hard to make such natural acts of kindness come under the operation of maintenance, which always seems to imply a contentious and over-busy intermeddling in other men's matters. Though one may assist another as above, he ought not to give him any money towards carrying on his suit." As regarded justification of acts of charity, Section 25 stated: "It seems to be agreed that anyone may lawfully give money to a poor person to enable him to carry on his suit." Lord Abinger said: "If a man were to see a poor person in debt and oppressed, and without means of obtaining redress, and furnishes him with money or supplies him with an attorney, it would require a very strong argument to convince me that that man could be said to stir up litigation or be guilty of the crime of maintenance." In connection with this ground of justification, he might also call attention to that section which had reference to attorneys taking up the suits of poor persons. "It is certain," says Hawkins, "that they ought not to carry the cause of another at their own expense upon the mere speculation of obtaining money from the defendant in the event of success. That cannot, as it seems to me, be described as an act of charity, but would rather fall directly within the mischief against which the law of maintenance is directed. It is the carrying on of a suit, in the subject matter of which he has no interests for the purpose of getting costs from the other side." It was not, however, and could not be seriously suggested here, that the maintenance of Mr. Harness was at all due to a neighbourly action, or to the impulse of a charitable spirit. He would not dwell, therefore, on these grounds of justification, but proceed at once to the consideration of the question whether he had reasonable grounds for believing he had a common interest with Dr. Tibbits in the result of his action. If this question was answered in the affirmative, he would be entitled to have a verdict entered for him, but not otherwise. The sort of interest required to absolve a person of the charge of unlawful maintenance was illustrated by Hawkins in section 12. He says, "As to how far some acts of this kind are justified in respect of interest in the thing at variance, it seems to be clearly agreed that if a tenant in tail or for life, being pressed, he in remainder or reversion may lawfully maintain a suit with his own money," there were other cases mentioned in following sections. Many cases were to be found in the books in which persons had been held to be justified in contributing to the expense of suits brought or defended by others with the object of defending or enforcing a common right in which all were interested. A case in point was that of "Findon and Parker." He found, however, no case in which a person had been held justified in maintaining a suit in which he had not an interest in the thing at variance, nor any in which such a claim of common interest as this had been even suggested. He now asked himself what was the thing in the plea or suit called the "thing in variance" in an action, or "the common interest" in which the plaintiff or defendant might justify the maintenance of such action or defence? Surely it must be that which the plaintiff claimed as the subject matter and object of his action—that which he would attain as the result of success, whether such action be detinue of goods, trespass upon lands, disturbance, assault, libel, slander, or any other actionable right or grievance. The common interest must be in the attainment of such success. It must be something far beyond a mere wish for the success of the suit. It must be something more than a mere hope or expectancy that he might by upholding one of the parties do great service to a friend, or that he might thereby gain control and influence over its conduct and turn the thing to his own advantage. Such hopes and expectancies would amount to nothing in the way of justification unless he had a real interest in the subject matter of the suit or the thing in variance. If such hopes and expectancies as real interest in the subject matter sufficed, maintenance would become very common indeed. He used the phrases, "common interest in the subject matter of the suit," and "common interest in the thing in variance," for the reason that there was a difference between the two. For instance, an action might be brought by one person in respect of interference by the defendant with a right of way, or with a common. Maintenance in such a case would be clearly justifiable, because of a common interest in the subject matter of the action. Again, an action could be brought for assault. Damages in such an action could only be recovered for trespass upon the person of the plaintiff, and there could not possibly be any common interest; yet in the course of the action an issue might be raised, the determination of which would clearly have a common interest. If, for instance, A accused B of a common assault, and B pleaded simply not guilty, C would not be justified in maintaining A's action, because he could have no common interest; but if B pleaded as a justification that A was trespassing on his lands and refused to go off, and A replied that he was pursuing a right of way common to himself and others, C would be justified in maintaining A's action, as being one in which he had a common interest. He would now deal with the present case. The libel complained of contained also libellous imputations upon Mr. Harness and his Institute, but the libels upon the defendant Harness did not form any part of the cause of action, nor was there any issue raised as to his character or conduct. His work and his appliances, it was true, might form a prominent topic for the comments of counsel, and he might naturally feel deeply interested in the sense of being anxious to see the adverse comments met and refuted, and the utility of his belts and appliances established before the world. There were many persons not parties to suits whose character and actions were undoubtedly made the subject of very free comment during the progress of the cause, but this did not constitute such a common interest as to justify maintenance. In Tibbits's character or success, so far as he was concerned, Harness had no legal interest, and his own character or conduct could neither be judicially condemned nor justified, and any issue raised on questions attaching to them would have been immaterial. In no proper sense, therefore, could the libel upon Mr. Harness be a part of Dr. Tibbits's case. Tibbits's character alone would be the subject matter of the action, and the right to maintain his action was the sole matter in variance. The defendants in that action pleaded, so far as Dr. Tibbits was concerned, that the article was *bonâ fide* comment upon a matter of public interest, and upon that issue alone was the verdict for the defendants taken. He knew it might be said that it was hard when a man's character was attacked that he should not be allowed to support by his money the cause of a person who, in defending his own character, must of necessity to some extent support that of another who was attacked with him. That might be so, but in his opinion to allow another to help another in litigation in respect of matters which did not immediately and directly concern him, would lead to more strife and inconvenience than could possibly result from the present law. In the present case, however, he was not concerned with any such feelings of hardship, for in the action brought by the Medical Battery Company against the present plaintiffs, the defendant Harness had full opportunity not only of completely vindicating the character of the company, but his own. He preferred, however, to abandon that action. It was abandoned on April 28th, some months before Tibbits's action was tried. He went and sheltered himself under the wing of Dr. Tibbits. Even in Tibbits's action he did not do that which he might have done, viz., make himself a co-plaintiff. Had he done so he would have been entitled to all the advantages of an opportunity of clearing his own character as he would have had had he brought a separate action. This would have given, besides, common interest in the action, which he did not think he had under the circumstances. This was not a case in which a joint action could have been maintained, for had it been so, each might have maintained the other. It was merely an action in which two persons being libelled in one article, each might separately have recovered damages as though he had brought a separate action; but of course, if so joined, he would have been liable for costs in the event of failure. But acting as he did, although he made himself liable to pay Tibbits's costs, he took the chances of any advantages he might have derived in the action. This action was brought to counteract such a course of conduct. He was aware that it was not necessary to establish that a joint interest in the action actually existed, and that it would be sufficient to justify the defendant in maintaining Tibbits's action if, on reasonable grounds, he had a *bonâ fide* belief he had such interest—that, in fact, he had a reasonable belief in a state of things which, if true, would in law have justified him in maintaining the action. His erroneous belief as to what in law would justify him, and his *bonâ fide* belief in a state of things which would support his erroneous view of the law, would amount to nothing. He was of opinion that Harness had no such *bonâ fide* belief; that if he had such belief he had no reasonable grounds for it; that he merely availed himself of Tibbits's action to save himself from the risk of liability of the then defendant's costs; and that his conduct in all these respects was unlawful. Judgment must be entered for the plaintiffs for the amount of the costs of their defence.

Counsel for the defendant asked for a stay of execution pending an appeal.

The application being opposed by the plaintiffs, his Lordship said he would grant a "stay" on £500 being paid into Court, or security given for the amount.

Bankruptcy.

Accounts have been issued under the failure of Arthur French St. George, 16, Marine Street, Bermondsey, Surrey, electrician, showing liabilities £1,033 4s. 6d., of which £529 4s. 6d. is unsecured, and assets *nil*. The receiving order was made on June 12th on the bankrupt's own petition. He states that from 1886 to 1892 he was occupied in perfecting certain inventions of his own, which he subsequently patented. Two of the patents are charged to creditors appearing in the statement of affairs as fully secured, and the others have lapsed, or are of no value. The bankrupt attributes his present insolvency to the non-success of his patents, and to his liability for moneys borrowed to work them. It appears that the bankrupt filed a petition for liquidation in December, 1883. His liabilities then amounted to £3,741, against assets estimated at £142. A proposal for a composition of 1s. 6d. in the £ was accepted by the creditors, but the bankrupt states that some of the principal creditors did not receive the composition. In November, 1886, an order of adjudication was made against the bankrupt, his liabilities being then returned at £4,504, against assets estimated at £40. The bankrupt states that his liabilities, under those proceedings, included claims amounting to £2,962 10s., of creditors who did not receive the composition under the failure of 1883. He has not obtained a discharge under the proceedings of 1886. At the first meeting of creditors, held on July 12th, no resolution was passed, and the Official Receiver is trustee of the estate.

Edison-Bell Phonograph Corporation.

Before Mr. Justice Stirling, in the Chancery Division, in the case of the Edison-Bell Phonograph Corporation, Limited, *v.* Smith and Mansfield, Mr. Moulton, Q.C., made a motion similar to the motion in the action of the same company against Hough on 31st ult. His Lordship made an order consolidating the two actions, but refused to make any order on the motion.

CORRESPONDENCE.

Patents.

The moral of the article, "Patents," in the last issue of the ELECTRICAL REVIEW, is that every person who finds in a foreign book or specification a process which suits his purpose, is at liberty to patent it as his own invention, and by doing so, *i.e.*, by paying £4 to the Patent Office, he becomes the owner of a monopoly which only a costly litigation will withdraw from him.

A man who finds a purse in the street and appropriates it is liable to prosecution; but, if instead of picking up money he picks up an idea of an invention, he is considered as the exclusive and *bonâ fide* holder of the invention.

To conduct this lucrative business, nothing is wanted but audacity—a great deal of audacity—and money at command. The writer of "Patents" has mentioned the cyanide of potassium lawsuit *a propos* of my invention of electrodes for secondary batteries, made of chloride of lead fused and cast on grids, for which a patent has been granted by the Patent Office to others, who sold their rights, which are really my rights, to a powerful company; but the case of the chloride of lead battery has nothing in common with the cyanide of potassium litigation.

Whatever may be the decision of Mr. Justice Romer, I will, as soon as the question is no longer *sub judice*, present the problem of the validity of the cyanide patent under what I call its true light.

Even if the Cassel Extraction Gold Company lose their case, there is not a shadow of a reproach of piracy or dishonesty against Messrs. MacArthur and Forrest, who may have been ignorant of what was known about cyanide of potassium as a solvent of gold. They never defrauded any true inventor of the process they work. There is no similarity between the chloride of lead and the cyanide patents.

Here is another illustration of the iniquitous grant of patents in most countries, and especially in Great Britain.

A specification has been lately filed, the claims of which are simply the recital in brief of a process which has been fully described a few years ago in a well-known book. Being interested in the subject of the patent, and having patented abroad a process for the same object, I warned the applicant that he had no right to the claims of his specification, and, finally, I opposed it. I sent to the Patent Office Comptroller the printed documents, showing that the process was known not only abroad, but in this country. My ground being only that the so-called invention of the applicant was known, and therefore public property, after a long correspondence I received from the Patent Office, on Saturday last, a letter stating that "this is a ground of opposition not permitted by the provisions of the statute." But what is the worth of a patent which later on can be invalidated because the process is no novelty, that the patentee is not the true and first inventor of his patented *invention*, and that he learnt it from a book or document which some English people may fairly be supposed to have read?

We cannot say *dura lex, sed lex*. The rules of the Patent Office have nothing to do with law, which means justice or equity; they are in some cases nothing but the sanction and consecration of unfair play, and of the discreditable, but profitable, business carried out by unscrupulous people who patent, sell, or work what they never invented. The writer of the very clever article on "Patents," who says: "On every point we are satisfied that the British system is the best," seems to me—but I may be mistaken—either an official of the Patent office, or one of those whom I denounce to public opinion as dealers in borrowed inventions.

E. Andreoli.

Training of Electrical Engineers.

You will, perhaps, pardon me for opening a discussion on a subject which, I suppose, is already well worn. But although a great deal has been said, very vague ideas seem still to exist as to the proper method of training electrical engineers.

I have, I may say, completed the purely educational portion of my career, and looking backwards, I often wonder whether my training has been directed in the best direction.

With this thought in my mind, for my own benefit and for the benefit of those about to enter this profession, I would ask for opinions on several points.

1. What length of time should be spent on theoretical and on practical training?
2. Should theoretical training precede practical, or *vice versâ*, or should they be carried on simultaneously?
3. Of what should the theoretical work consist?
4. At what age should purely technical training begin?

Of course, I am quite aware that much depends, firstly, on the individual, and secondly, on the means at his disposal; but taking the average cases, what are the answers to the above questions?

I have my own views on the subject, but I should like to hear the views of those who have more experience; and I am sure that, if they will give us the benefit of that experience, they will confer a boon on many a young man who has the idea of becoming an electrical engineer.

Apologising for thus intruding on your valuable space,

W. P. S.

Electrical Fire-Damp Detector.

In your Note under this heading in your current issue, you refer to an arrangement for testing in a mine for fire-damp with two platinum wire *coils* and a *storage battery such as used for miners' lamps*.

Now, as I have made some experiments in this line, I am interested and would like to know if this can really be done—in other words, what current and E.M.F. will it take to do it reliably? The idea of having two wires, one in pure air, and one in the mixture to be tested, is by no means novel, since it is done in Liveing's detector, which is worked by a magneto-generator, and has been used in mines for a considerable time, and to heat a wire by the battery used in a miner's lamp for this purpose, was proposed by Mr. Schanschieff several years ago, but I am informed he found the current required too large for his battery. My own experiments pointed to *at least* 3 amperes being required, and where is the portable battery that will give 4 volts, 3 amperes, even for short periods without serious fall of E.M.F. or injury to plates—the weight not exceeding 2 lbs. per cell, 4 lbs. altogether, assuming a 2-cell battery?

I think it would be of scientific interest, if nothing more, to know what is the size and gauge of the coils you refer to, and what current and voltage they require. The wires I got best results with were about No. 30 B.W.G., about ¾-inch in length. Source of supply: a quart size low resistance bichromate cell. Apologising for intruding on your pages, but hoping something really *au fait* is in the wind, *worked out* and suitable for use in a mine,

A. W. Bennett.

The Boynton Bicycle Railway.

I have just read the article on "Boynton's Bicycle Railroad" in your issue of the 10th inst.

Allow me to again correct a statement contained in that article referring to the proposed line between Cannon Street, Waterloo, and Charing Cross. I explained already in my letter of March 20th, in reply to similar observations contained in an article of yours of the 16th of that month, that there was no idea of building such a railway to be worked at a high speed.

This scheme is entirely independent of the proposed lightning express. It is simply a metropolitan line to connect Cannon Street and Charing Cross, to relieve the present congested state of the traffic, to be worked at ordinary speeds, the trains being timed to take about eight minutes from Charing Cross to Cannon Street.

I request that you will be good enough to insert this correction, as I feel sure you do not wish to convey a wrong impression to the minds of your readers.

F. B. Behr.

August 14th, 1894.

Electric Lighting Contracts and Professional Advice.

My attention having been called to your leader on the above subject, which appeared in your issue of the 13th ult., I write to state how thoroughly I agree with all your remarks,

which without doubt will "go home" in many quarters, and in ordinary parlance the caps will fit many heads.

Through the too ready willingness to believe in the good faith of ones neighbours, no doubt many consulting men have had experience very similar to what you have indicated.

There cannot be much difference of opinion that buyers and users of electric plant are badly advised when they place their interests solely in contracting engineer's hands, whether they be acting at the moment as contractors or consulting men.

It is the purely professional man only who is in the happy position of being able, not only to keep a bird's eye view of all inventions that are continually being made, but to recommend and use those which would be most conducive to his client's interests; contractors and manufacturers being nearly always more or less interested in some speciality or another, such as a dynamo or motor, which has perhaps given ½ per cent. more efficiency than some other, or it may be a new system of laying mains, some patented switches or fuses, &c., and again one generally finds that specifications drawn up by contractors or manufacturers, invariably specify a certain make of dynamo, motor, or fittings, which at once prevents "free" tendering, whereas it is most important that all specifications should be as open as possible, allowing tenderers to quote for what plant they like as long as they comply with the prescribed efficiencies, insulation, output, &c.

The many continuous improvements in electrical and mechanical science that are being made, are due in a large measure to the more or less friendly fighting between consulting engineers and contractors, the former urging the latter to go one better, as it were, over and above the last best result; the great improvements made in the insulation of submarine cables being an example.

Electrical and other engineers should, without doubt, adhere to that portion of the profession which they have elected to follow, instead of tending to alienate themselves from brother competing firms, and the professional branch, to whom they owe so much.

I observe in your contemporary, *Lightning*, of the 19th ult., that while it quibbles at some of the wording of your article, it agrees with it in the main; that Messrs. Basil Gee and Mr. J. Hardie McLean whom it puts forward as qualified experts equally with yourself, clearly state that contractors and manufacturers are necessarily biassed in favour of the plant they are most interested in or have to sell.

The current issue (*Lightning*) endeavours to be funny at the expense of "Consulting Engineer," who wrote a capital letter, and which you published in yours of the 3rd. It is very easy to criticise other's remarks, but another matter to make original ones or suggest better. The idea of having some distinguishing title or diploma for all those engineers who act truly and purely as professional men is a good one, and one that should certainly be followed up.

I am fully aware that anyone elected as a full member of the Institution of Civil Engineers or Institution of Electrical Engineers, must show by past experience and practice that he has substantial abilities; but membership does not give specific status as a consulting man.

The requirements for Membership of the Institution of Civil Engineers are now, I am pleased to note, much more stringent than they used to be, so that the desire of the Council to maintain, with an upward tendency, the status of all full Members is bearing good fruit.

The Institution of Electrical Engineers, however, is not nearly so stringent, as will be seen from Rule 9 (*re* qualifications of Members), as here both contractors and manufacturers who have had the required pupilage and experience are accepted.

What I would suggest is, that Members should be of two classes, viz., professional members and ordinary members, the extra qualification for the former being a fixed number of years' professional practice, while their subsequent work should be zealously watched.

I do not for one moment suggest that a contractor or manufacturer is not every whit as clever or has less knowledge than the consultant, but what I do say is that by the nature of their business they cannot have the same unbiased free opinions they should have when called in to "prescribe," and so should never be put into or take up the false position.

Professional.

August 15th, 1894.

THE BRITISH ASSOCIATION.

It would be interesting to have a consensus of opinion upon what the B.A. has accomplished this year at Oxford. The chemists would say, and perhaps rightly so, that to them the gathering has marked an epoch; the economist might claim that the appreciation of economics had been most marked, while the anthropologists would unhesitatingly affirm that, popularly speaking, their science had made wonderful progress. The electrical engineer will not, however, be profoundly stirred by what has happened in his absence at the British Association. The paper read by Prof. Silvanus Thompson on "Some Advantages of Alternate Currents," was a noteworthy one, but the discussion was very lame. Mr. Preece made an effort to support Prof. Thompson's views, "but he didn't know why." Prof. Kennedy could have said a good deal but did not, and so the matter resolved itself into an unequal duel between Mr. Parker, as representing continuous currents, and Prof. Silvanus Thompson, as representing the new alternating current.

Considering, however, the Sections in their alphabetical importance, we were struck with the popularity of the Mathematical Section for the first few hours of its sitting. The presidential address was sat out by a large and distinguished audience, and even the first two papers were borne with to the end. After this there was a wholesale dissipation of the audience. In spite of the brilliant theories that are occasionally propounded, and the scholarly and scientific disquisitions one often hears, this Section has a marked capacity for boredom. You cannot always listen, and to sleep one is ashamed. There is, however, one good trait about Section A which deserves recognition, that is, an audience is by no means a necessity.

Electrically speaking, Section A has fathered nothing of importance. Manful efforts were made to invest the subject of electrical standards with something like it, but the interest displayed was most lukewarm, and this lukewarmness was confined to some three or four. The sectional proceedings opened strongly. The joint paper by Lord Kelvin and Mr. Maclean on the "Electrification of Air by the Subtraction of Water" was interesting, though it brought forth strong dissent from Dr. Lodge. "Photo-Electric Leakage," communicated by Dr. Lodge, was to some extent a repetition of what he has already told us, namely, that light materially assists discharge. The most astonishing thing in the paper was the number and diversity of the subjects experimented with, which ranged from leaves to pewter pots. On the following day most of the physicists were to be found in the Chemical Section hearing Prof. J. J. Thompson dilate upon his favourite topic of electric discharges through gases. The experiments—brilliantly performed, by the way—were much the same as those given at the Royal Institution, which have been already described in the Electrical Review. The main purpose of these experiments was to provoke a discussion among the chemists, and a fairly interesting one followed. There is little more of importance to record in Section A, and we will turn for a moment to the doings of the Mechanical Section. The few electrical papers presented in this section practically saved the meeting from being a barren one. We speak elsewhere of Prof. Kennedy's masterly address, and we reproduce in this issue some of the principal papers. Mr. Bryan Donkin had something really good to say on what constitutes economical temperatures of engine cylinders. The hunting of governed engines is of the greatest importance to electrical men, and we must say that Mr. Swinburne handled the subject in an able manner. We are quite at one with him in his advocacy of isochronous governing, but unfortunately the best isochronous governor made at the present moment is not isochronous. Mr. Preece had little to add to his pet subject of signalling through space, except to further confound the supporters of the earth current theory. It is impossible, in a hasty review of the doings of the B.A., to do much more than mention Prof. Thompson's communication on alternating currents. It goes without saying that it was an important addition to our knowledge on the subject; and it is to be hoped that the matter may be brought before the Institution of Electrical Engineers for adequate discussion.

Mr. Parker's account of the working of the Oxford Station was interesting, but, as we have before remarked, it seemed

a pity that the author of this paper and Prof. Thompson should have been brought into conflict. During these discussions we had some amusing, if remarkable, statements from Mr. Preece, about the cost of electricity. We all know Mr. Preece's views on gas at 3s. being equal to electricity at 6d. per B.O.T. He was a little more explicit than usual on the subject, and gave us the basis of his contention—viz., that a 15 C.P. gas burner never gives more than 10 C.P., and therefore it is fair to compare an 8 C.P. incandescent lamp with it. It might be so if the incandescent lamp always gave 8 C.P., but Mr. Preece knows as well as anybody that an 8 C.P. incandescent does not long give that power under normal conditions. His promised paper on the efficiency of incandescent lamps might have thrown some light on this, and might have involved Mr. Preece in a contradiction.

Of the new gas brought before the Chemical Section by Lord Rayleigh and Prof. Ramsey we have heard a good deal. The following extract from the *St. James's Gazette* puts the matter in a clear light:—

"It appears that Lord Rayleigh, in the course of his researches upon the density of gases, found that nitrogen from the atmosphere was heavier than that from other sources. At this point Prof. Ramsay took up the matter, in the belief that the atmospheric nitrogen could not be pure. His experiments resulted in the knowledge that the atmosphere contained a small quantity of gas still more inert than nitrogen. It was found that if air is subjected to electric sparks, the resulting nitrous fumes absorbed by potash, and the excess of oxygen by alkine pyrogallate, there remains a residue which is neither oxygen nor nitrogen, as can be seen from its spectrum. The same gas may be isolated by exposing nitrogen obtained from the air to the action of magnesium. As the magnesium gradually absorbs the nitrogen the density of the residue rises to nearly 20. The newly-discovered substance constitutes 1 per cent. of the atmosphere, and gives a spectrum with a single blue line much more intense than a corresponding line in the nitrogen spectrum. About 100 c.c. of the gas has so far been obtained. A further discovery was announced by Prof. Wanklyn, who stated that as the result of most laborious investigation carried on conjointly with his friend and colleague, Mr. Cooper, there was found to exist a multitude of carbon compounds wherein the quantity of carbon in the standard volume is not a multiple of 12, but of 6. The consequence follows that the atomic weight of carbon is 6, as was commonly believed by chemists a third of a century ago."

NOTES.

Another Revolutionising Railway System.—Our contemporary, the *Electrical World*, states that a consulting engineer informed the editor that an enthusiastic inventor came to him recently with the following idea:—The rail for his street railway is made of a flexible band, and large electro-magnets are placed behind each of the wheels, which, by their magnetic attraction, will raise up the rail behind each wheel, thus forming little hills, down which the car will move by gravity, these little hills following the car as it travels along. As the rail neither advances nor recedes from the magnet, no power will be required other than a small amount of current to excite the magnets. He was told that his mistake was to come to an engineer with his project; he would no doubt be able to obtain financial assistance to form a large company to introduce his invention if he went to some of the many capitalists who do not believe in science or in the advice of an engineer. It was suggested to him that even the power for the magnets might be dispensed with if the flexible rails be made to pass over pulleys directly behind the wheels. It reminds our contemporary of a scheme for canal boat repulsion, due, it is believed, to Mark Twain,* in which the canal was made in the form of an inclined plane, down which the boats would slide by gravity; but as that involves difficulties for the return trip, he improves it by making the boats themselves in the form of an inclined plane instead, and they would then slide down in any direction in which they were pointed.

* Should not this be Max Adeler?

A Fortune in Arc Lamps.—The electric lighting market has been inundated recently with arc lamps, good, bad and indifferent. That there is a fortune in one of the first named class is evident from the note near the end of page 210.

Insulation.—There is one remark in the letter of our correspondent "Professional" which shows distinctly that his experience of the insulation of submarine cables is nil. We know of no great improvements, but we do know that the higher the insulation required the greater is the percentage of foreign matter put into the rubber or G.P. as the case may be.

Bolton Electric Lighting.—The Corporation have appointed as electricians for their new electricity works in Spa Road, Mr. E. W. Dickenson, of Wigan, and Mr. J. Pilling, of Bolton, the commencing salary being £110 per annum. There were originally 15 applicants.

The Behaviour of Bismuth in a Magnetic Field.—The changes of resistance which a spiral of bismuth wire undergoes when placed in a strong magnetic field formed the subject of a paper which was contributed to a recent meeting of the Physical Society of Berlin by Prof. H. du Bois Reymond, Ph.D. It may be remembered that the phenomenon was first noticed by Lord Kelvin, who measured the change in the case of a bismuth spiral situated in a magnetic field of maximum strength, 12,000 C.G.S. units. He also found that the curve of resistance in the field, compared with that of the resistance outside the field, exhibited concavity in its upward trend, and then became straight. The resistance in the field of maximum strength was 1·7 that in zero field. Prof. Reymond has been working at this subject in conjunction with Dr. Henderson, using those powerful circular electro-magnets, which were recently described in the Electrical Review, giving an intensity of 38,000 C.G.S. units. He has measured the resistance of bismuth spirals, and observed that the curve of resistance takes a further straight line course, so that the resistance of the field of greatest intensity is three times as great as in a field of zero intensity. By measuring the resistances in a magnetic field at different temperatures, the professor found that in weak fields a rise of temperature increased the resistance, in stronger fields, the effect was less, and became zero in a field of 7,000 C.G.S. units. In still stronger fields the resistance of the warm spiral was less than that of the cold. Prof. du Bois Reymond has hitherto conducted his experiments in temperatures ranging from 0° to 25° C. He proposes to extend them to 100° C.

Electrodes for Resistance Determinations in Electrolytes.—Although not of general interest to our readers, and therefore unsuitable for condensation, there is a paper in *Wiedemann's Annalen der Physik und Chemie* [2], li., pp. 346—350, which some will probably find of special interest. The paper is by F. Kohlrausch, and deals with and describes a large number of plane and cylindrical platinised platinum electrodes, suitable for dipping into electrolytes whose resistance is to be determined. One of the principal features of these electrodes is that the connections are made through double capillary glass tubes of 1·5 mm. bore.

Researches on some Dielectric Constants.—In a paper contributed by H. Jahn and G. Möller to the *Zeitschrift für Physikalische Chemie*, xiii., pp. 385—397, and entitled "Molecular Refraction," there is a number of data concerning the dielectric constants of various substances, chiefly of an organic nature. The paper really consists of an account of a continuation of the researches of Landolt and Jahn (*Zeitschrift*, x., pp. 289—320). From measurements for electrical waves of great wave-length, it has been shown that Maxwell's relation, $n^2 = K$, between the index of refraction and the dielectric constant, is true for a considerable number of solids and liquids. Jahn and Möller have pursued these measurements, carefully observing the refractions and the dielectric constants of the substances under examination. It does not appear, however, from their results, that Maxwell's relation holds for all substances. This, however, may possibly be due to inaccuracy of observation.

"Writ Sarcastic."—The following letter from Mr. R. C. Alabaster, of Bournemouth, appeared in yesterday's *Standard*, explaining the new gas theory :—

Lord Rayleigh and Prof. Ramsay have announced a new constituent in the atmosphere; and I must confess I am not surprised, for, for a considerable period, I have been convinced that in the general atmosphere of England there was a prevailing element which I had not noticed in my earlier days. In my ignorance I had attributed it to the Sanitary Board and the "ventilation of drains." At first I had the difficulty that Lord Rayleigh stated, that the gas was singularly inert, and I was under the impression that sewer-gas was highly explosive, and peculiarly motive; but, as the sanitary authorities have put up a sewer ventilator within a very short distance from my bedroom window, I am forced to recognise that, in the opinion of experts, sewer-gas is singularly inert. Is by any chance the new gas simply sewer-gas introduced into the atmosphere by sanitary authorities?

West Hartlepool and Electric Lighting.—The Town Council have appointed a committee to collect information from towns where electric lighting is in operation.

Club Lighting.—Barrow Working Men's Club and Institute find it would be too expensive for them to light their premises with electricity.

Obituary.—We regret to hear of the death of Dr. Charles R. Alder Wright, the eminent chemist, which happened on Wednesday, July 25th. He was only 49 years of age, and had been a member of the Society of Arts for 20 years. He has, during his career, devoted himself largely to research work, and has read papers and delivered lectures, Cantor and otherwise, before the Society on matters connected with the chemical industries.

We also learn of the death, which occurred quite recently, of Mr. Charles Liddell, at the age of 81. In his earlier days Mr. Liddell did a good deal in the construction and working of railways. As a partner in the firm of R. S. Newall & Co., he at one time took an active part in the laying of telegraph cables. During the war in the Crimea, he laid the cable between Varna and Balaclava.

Ealing Electric Lighting.—The buildings of the central station are approaching completion. All branches of the work are now so far advanced that the supply current will be commenced early in September. During the month of October the Local Board propose holding an electrical exhibition in the Victoria Hall or other suitable place, so that customers may have an opportunity of seeing the uses to which electricity could be put.

Self-Induction Compensation.—When the excitation current of a dynamo machine is interrupted the electromotive force of the self-induction current may reach a value sufficient to break down the insulation of the machine. In order to prevent this, M. Hermann Muller connects a non-inductive resistance across the excitation resistance, this resistance being connected up just before the main circuit is broken. If the non-inductive resistance has twice the resistance of the excitation resistance, then the electromotive force of self-induction cannot exceed twice that of the excitation current.

A Continental Electric Railway.—Advice from Vienna states that the Hungarian Minister of Commerce has granted a concession for the construction of an underground electric railway in Pesth. This line will be two English miles in length, and will pass from Giselaplatz to the Thiergarten. It will be the first electric underground railway in Continental Europe. It is to be opened on April 1st, 1896.

Electric Lighting of Ships Passing Through the Suez Canal.—From remarks in several of the daily papers, it appears that out of the 3,341 ships which passed through the Suez Canal in 1893, 92 per cent. used the electric light, thereby saving nearly 11 hours in the transit, the time occupied in passing through being with the electric light 19 hours 52 minutes, and without the light 31 hours 24 minutes. The number of British vessels included in the above total was 2,405, besides 59 men-of-war, and it is satisfactory that only nine casualties were registered at the British Vice-Consulate at Suez of vessels having grounded or collided.

Electric Light at Leicester.—The Assembly Rooms are to be lighted by electricity; £250 is to be expended upon wiring and fitting the buildings.

Exhibition Langwidge.—We give the following examples of language hailing from Spain:—"Commercial Exhibition.—Bilbao.—Spain. Universal and permanent centre of propaganda of all that the humen activity produces. Address: Telegraf—Commercial.—Bilbao.—Spain. Post—Sr. Director de la Exposieión Comercial en Bilbao.—(Vizcaya).—Spain. Telefon—Teléfono letra E. To the Public: The Commercial Exhibition, disposing of great relations and an intiligent personal to ocupy in the many services sohich is the objet, and also large stores wehere we can easy exhibit and store all kind of produces we have accorded to patronise the universal propaganda in relation of the means that we rekon puting in vigor the following tarifs:—Jhess tarifs can only be used by those which to this Centre their representation for the sale, buying or changing and osther services combined withit. Additional tarifs: No. 1.—Address es advertisements catalogues, prospects and price list are distributed gratis inside the Exhibition. No. 2.—It isalso admited gratis to be exhibited all objects which exceds not the size of half a meter cubic exceding that size it will be paid the ordinary tarifs. Important Note.—As we are finishing our werks which we began sometimes ago for the publication of a monlhly be Boletín (neddful for every buyer and salesmand) which will distribnted gratis in all nations we beg a note of what the wish to advertise the manner, and in which lenguage to send us as beuick as possible etc. el etc.—The Director, F. Arias." The following specimen speaks for itself:—"Ampliation.—Eor the ciose effects of the Permanent and Universal Commercial Propagacion the Exihibition puts in easy relation the productes with the buyer, receiving orders of all sorts of antecedents, broking, sales, buyings, bargains payments, recepts, comisions, consignations to the costumhouse deposits, importations, exportations, international asurings by sea, etc. We charge ourselfes of informations, insspections, studies of projects, directions of privat constructions, explotations of mines, mounling of machins and admit to lhese purpose advertisings, addresses of buyers and salers (to be exhibited in the Boletin of the Universal propaganda, in the great book Importations and Exportations, of the whole world), catalognes, price, lists, etc. Samples of productions, sciences, industry, arts and the comerce in general as insignificant it may be minerals, vegetables, publications, news papers scientific, religions and industriel books, music, muchins, vehicles, mecanisms instruments tools etc. All sors of drinks. Earthware, masonery, iron furniture, engravings, pictures, sculpture of wood and stone objects of art, watches, glassware, lookingglanes, jewels, arms, thread coiton wool silk dather feathers with one word all that the nature and humanity produces. All kind of obligations cotizations are bought and sold etc., etc. Goods are takenin in deposit acording before hand with the Direction. Dates and references as well as the entrance to the Euhibition are given gratis." What a pity there is no longer an Inquisition in Spain. The native compiler of "English as she is spoke" would have made a fit subject for a modern "Auto da Fé."

Production of Electricity by the Evaporation of Liquid Carbon-Dioxide.—It has been remarked by more than one observer that a strong jet of carbon dioxide obtained from its liquid may, on expanding into the atmosphere, produce an electric charge of marked intensity. Riess, Joly, Ducretet, and more recently Hausknecht, have published observations on this curious phenomenon, which are described anew by Dr. L. Bleekrode, in the July impression of the *Philosophical Magazine*. Dr. Bleekrode attaches great importance to the minute particles of solid carbon dioxide, which he asserts to be present in the escaping gas, these particles, he says, having a great propensity to become electric. Under certain circumstances, the charge of electricity produced is of a negative character, under others it is positive, and the author devotes some space to an enquiry into the causes of these opposite states of electrification, and formulates a very plausible theory. For this we must refer our readers to the original paper, which is well worth perusal.

Stockton Electric Lighting Order.—The Town Council recently petitioned the Board of Trade for an extension of their electric lighting order, but that authority would not grant the application unless the council agreed to give effect to the provisions within one year. The council have replied that they would do this within two years.

The Electric Lighting of the Houses of Parliament.—In the House of Commons last week, in answer to Mr. Weir, Mr. H. Gladstone said: "This matter of providing the Houses of Parliament with electric installation has already received careful consideration. The evidence before me shows that no complete installation of electric lighting machinery and plant can be established within the building without occasional serious interference with its proper ventilation, and we have already some experience with a partial installation which confirms this view. The generation of electricity within the building has been abandoned, both for this reason and because the boilers now existing are no longer strong enough to bear the strain of working both the ventilation and lighting systems. The cost of constructing a complete electrical station outside the building in connection with the warming and ventilating arrangements has been considered, and it would probably reach £30,000 to £40,000; while the expense of wages and maintenance would also be very heavy. The subject will receive further attention, but, having regard to all the circumstances of the case, it must be deferred for the present. Taking into account the capital outlay, I am not at all prepared to admit that the saving would be anything like that suggested."

The "Brunsviga" Calculating Machine.—This beautiful apparatus was exhibited at the annual meeting of the North of England Institute of Mining and Mechanical Engineers, Newcastle-on-Tyne, on 4th inst. Mr. A. E. Gilbert, A.I.E.E., of Malvern House, Whitley, explained the working of the machine, which multiplies, adds, subtracts and divides, and all the members were highly interested and amazed at the simplicity and accuracy of its manipulation. Everybody dealing largely with figures and statistics of all kinds would appreciate the great saving of time and mental labour ensured by its use. We may add that Prof. C. V. Boys, F.R.S., of the Royal College of Science, Prof. A. S. Herschell, F.R.S., the well-known astronomer, and Prof. F. J. Smith, M.A., of the Millard Engineering College, Oxford, and an occasional contributor to our columns, have spoken in the most favourable terms of this apparatus.

Government and the Telephone Companies.—A memorandum was issued on Monday last explaining the agreements entered into between the Postmaster-General and the National and New Telephone Companies. Under these agreements, embodied in a Bill which has received the Royal assent, the companies will be allowed to connect their exchanges with post-offices, thus enabling their subscribers to telephone messages for transmission over the public telegraphs, or through the post as letters, or for delivery as express letters, and to obtain the services of messengers, or the use of the trunk telephone wires of the State. The companies will abandon their right to construct trunk wires, and the Post Office will purchase from them such as they have already erected. In addition the Post Office will gradually provide additional trunk wires, so that there may ultimately be a complete system of communication between all the important towns in the kingdom. The messages telephoned to post-offices for delivery will have to be limited in length, and it is proposed to adopt the twofold limit of three minutes and 30 words. The charge will be the same as for an ordinary express letter, namely, 3d. if the address be within a mile of the post-office where the message is written down. For conversations on the trunk wires of the State the following will be the charges:—For any distance not exceeding 20 miles, 3d.; for any distance exceeding 20 miles and not exceeding 40 miles, 6d.; for every additional 40 miles or fractions thereof, 6d.

Redfern and Electric Lighting.—The Redfern (Australia) Town Council recently instructed their Mayor to buy 250 electric lamps for street lighting at a cost not exceeding 5s. per lamp.

Fatality on the City Electric Railway.—An accident happened at the Elephant and Castle station of the City and South London Railway Company last week. A lift attendant named Muldoon entered the well while some men were examining it. The lift descending, he was caught between the body and frame and crushed, death being due to shock and concussion of the brain.

An "Exact" Arc Lamp.—A circular, the composition and Keelyese style of which is sufficient to wreck the prospects of even an exact arc lamp, has reached us from America. The claims made for the lamp, the invention of a Mr. Irish by the way, are so numerous, and couched in such bombastic "high falutin'" language, that we are prone to suspect that the merits are more in the circular than in the lamp itself. The Irish-American lamp, from what we can gather from one or two of the more lucid passages, is regulated on the well known hot-strip principle, the expansion and contraction of a conductor carrying the current actuating the feed, and it appears to be precisely the self-same apparatus that we noticed in a leaderette and illustrated article in our issue of November 4th, 1892; but instead of describing the invention, if there is any to describe, this is how the circular "patters" along:—"The inventor seems to have recognised certain difficulties in endeavouring to combine the heat principle to the ordinary clutch used in combining the electro-magnet, and has consequently directed his attention to such a combination that is adapted to be effectually controlled by the movements of the thermo-conductor."

At Last.—For years we have looked in vain for any American appreciation of the fact that no nation can suffer a loss or misfortune without some of the loss being felt by others. We find, however, in the *Railroad Gazette*, of New York, for August 3rd, the plain declaration that when an Englishman or a Frenchman loses in unprofitable ventures, Americans are bound to suffer. This, while true, is so entirely foreign to American modes of thought and business ideas, as to be worth placing on record. Perhaps, in course of time, the genius of the American nation, of which we hear so much, may even perceive the fallacy of protective tariffs. American attitude towards England—her very best customer—has always been hostile, doubtless owing to the hazy notions which prevail in the land of freedom, so called, we should say, on the principle of *lucus a non lucendo*.

How to Increase Candle-Power.—An expert who was called on by the Council of an American city to interpret a clause in a contract with a local electric lighting company, is said to have done so after the following fashion:—"The arc lights are hung at the street intersections, and each one throws its light in four directions; 2,000 C.P. of lights on each of the four streets, therefore, cannot be expected. An arc light which throws 500 C.P. of light along each of four streets is a 2,000 C.P. light, as called for in the contract." What a pity there were only four streets at each intersection; had there been eight the same lamp would have been, according to this expert, a 4,000 candle-power arc. This is probably what a New York exchange would call good and original work; the latter it certainly is.

Ashford Delays.—The Local Board have decided that no action shall at present be taken with respect to electric lighting.

Patents.—From the German Patent Office, where official examination is strict law, a patent has been issued for an impossible dynamo-electric machine, a unipolar dynamo which cannot generate current. This is another example of the failure of the Official Examiner of patent applications to separate the chaff from the grain, and amply bears out the contentions urged by us in our leading article of last week.

Telegraph Wire Exports.—During the seven months ending July last, the value of the telegraph wire and apparatus connected therewith exported from this country reached the large total of £1,187,224, as against only £556,500 in the corresponding period of last year, and £701,741 in the first seven months of 1892.

Birmingham Telephone Service.—Subscribers to this service seem to be very dissatisfied with its working. The company, however, declines to take any notice of anonymous letters published in the local papers, or of any complaints that may be made over the wires to operators.

London Chamber of Commerce.—At a meeting of the Electrical Trade Section, held on Tuesday last, Mr. E. Garcke presiding, Mr. Sydney Morse was unanimously elected a vice-chairman of the section.

Electricians at Play.—Some of our readers may not be aware what brilliant athletes the Veritys are. Last week we had the pleasure of congratulating the junior partner on his success as a sculler at the Maidenhead regatta. He has since distinguished himself in the punting world by carrying off the championship of England. Mr. George H. Verity also possesses much ability as a punter, for in the amateur punting competition at Cookham the other day he won the juniors' (single punting) in rare style, and he and his brother also secured the double punting leadership by a distance of ten lengths. We sincerely trust no one will misunderstand the direction in which the Veritys exert their "punting" abilities. We should be very sorry for it to be thought that they are patrons of the gaming table. We congratulate them upon being such able propellers of a punt which will bring them into no dishonour. What with the result of the Dunmow Flitch and the subsequent success of the Veritys in the sporting world, there is no telling to what lengths electrical men will go.

BUSINESS NOTICES, &c.

Electric Launches.—On Saturday last the Goring-on-Thames regatta was held, and the new electric launch *Aphrodite* was lent to the Thames Conservancy for the occasion, and was employed for clearing the course during the day. This boat was built at Goring in Mr. S. E. Saunders's boat yard. The arrangement of the electrical details have been carried out by Mr. H. A. Earle, of Messrs. Mather and Platt, Limited, 16, Victoria Street, Westminster, and the novel feature consists in the employment of a battery of chloride cells for the first time on the Thames. These are manufactured in England by the Chloride Electrical Storage Syndicate, Limited, 16, Victoria Street, London, and this launch has been specially built in order to demonstrate their superiority for this class of work, their large capacity for a given weight enabling distances and speed to be run without recharging, which were previously impossible. The cells with which the *Aphrodite* is fitted are capable of being discharged at a very high rate, and, on the measured mile, a speed of 9 miles per hour has been obtained, and this rate can be continuously maintained for about three hours, which is a record performance for an electric launch of this size; at slower speeds, namely, 6½ miles per hour, which is the usual rate of travel, and which is still considerably above the average speed of electric launches of this size, a day's run of nine hours can be undertaken, inclusive of the time taken through locks. One feature of the chloride cells is that although at very high rates of discharge their capacity for a given weight greatly exceeds that of other types, their increased capacity at low rate is still proportionately greater, and on this account, with the reduced speed of 5½ miles per hour, the battery power with which this launch is provided is capable of covering a distance of approximately 110 miles without recharging.

Price Lists.—From Messrs. Benham & Froud we have received a copy of their new enlarged catalogue of electric lighting fittings, and a revised and reduced price list. The book contains selections from the designs of electric light fittings designed and manufactured by the firm. Wall brackets, electroliers, pendants, hall lamps, lanterns, floor lamps, ceiling lights, church fittings, electric light glasses, silk shades, and some very ancient styles of fittings as well as very modern ones, are tastefully illustrated in the catalogue, while the price list details and prices the various articles. Among the new sheets we observe several popular designs of various types both in brass and iron, &c., which are said to be inexpensive. The catalogue is a first-class compilation which we can recommend to dealers in electric lamp fittings.

Messrs. Ludw. Loewe & Co. (Mr. H. F. L. Orcutt, London agent), have sent us one of their latest illustrated price lists of hammers and heating forges.

Mansion Lighting.—Philiphaugh, the mansion of Mr. Strang Steel, situated on the Borders, is being fitted throughout with the electric light. The dynamos are driven by two turbines, each of 15 H.P. Current will be used for lighting and heating purposes, also for supplying motive power to many machines for household and other purposes. The apparatus is being fitted up by Mavor and Coulson. There are three lamps each of 50 candle-power to light the avenue and front of the mansion; two of 50, three of 100, and 34 of 16 candle-power to illuminate the conservatory. Cooking, laundry work, and the driving of the machinery necessary for the joiners on such an estate will be all done by electricity. About 450 lamps will be fitted up altogether.

Aberdare Wants the Light.—The business men of Aberdare are hankering after the electric light, and rather than wait for their local body to bring it to them, they held, the other day, a meeting to consider how they might get it for themselves. Mr. J. C. Howell, of Llanelly, addressed the meeting at some length. Some time ago a provisional order was obtained, and it is now proposed to form a company. A committee has been appointed to take a trip to Pontypool for the purpose of gathering certain information.

British Thomson-Houston, Limited.—We are informed that the Laing, Wharton & Down Construction Syndicate, Limited, having purchased all the patents, rights, and privileges of the Thomson-Houston system of electric lighting, traction, and power transmission in the United Kingdom of Great Britain and Ireland and the British Possessions in Europe, will in future manufacture its apparatus in England. The Thomson-Houston Company having taken a material interest in the company, the Laing, Wharton and Down Construction Syndicate, Limited, with the sanction of the Board of Trade, has changed its name to that of "British Thomson-Houston, Limited," under which style it will do business in future.

The Gülcher (New) Electric Light and Power Company, Limited.—The creditors of the above-named company are required, on or before September 24th, 1894, to send their names and addresses, and the particulars of their debts or claims, and the names and addresses of their solicitors (if any), to the liquidator, C. Fitch Kemp, 73, Lombard Street, E.C., and, if so required, by notice in writing from the said liquidator, are, by his solicitors, to come in and prove their said debts or claims at such time and place as shall be specified in such notice, or in default thereof they will be excluded from the benefit of any distribution made before such debts are proved.

The Domestic Telephone Company, Limited.—The *London Gazette* states that at an extraordinary general meeting of the above company, held at 24, Fulham Road, S.W., on July 18th, 1894, the following special resolution was duly passed; and at a subsequent extraordinary general meeting of the company, held at the same address, on August 9th, 1894, the following special resolution was duly confirmed:—"That the company be wound up voluntarily under the provisions of the Companies' Acts, 1862 and 1867; and that Joseph Rayner Gibson, of 24, Fulham Road, S.W., be and he is hereby appointed liquidator for the purpose of such winding up."

Llandudno Lighting.—The Llandudno Electric Supply Company have for some months been desirous of introducing the electric light, but the commissioners appear to be blocking the way by taking action in the matter themselves. The engineer to the company (Mr. W. Kingsland), has been interviewed by a local newspaper representative, and from statements elicited from him, it would seem there is likely to be a little bother over the matter. The company, we believe, intend appealing to the Board of Trade.

Electric Street Calls.—The Walthamstow Local Board having decided to build a fire brigade station, are also about to have the whole town fitted with street calls, &c., the work having been entrusted to the Private Wire and Telephone Installation Company. Standard fire alarms are to be fitted in the various parts of the town, and communication is to be established between the new fire station and the firemen's houses.

Winchester and Electric Lighting.—The Corporation intend applying for a provisional order. The report of a committee specially appointed to consider the matter mentions the following as the necessary lamps:—155 lamps of 16 candle-power for side streets, 142 of 32 for main streets, and 14 lamps of 50 candle-power, with 133 oil lamps as at present costing £2 5s. each, making a total of £1,020.

Rugby School Electric Lighting.—We hear that it is the intention of the Rugby School Electric Lighting Company to replace the 100 horse-power tandem gas engine at the electric light station with a new one of the same type of 120 horse-power. The idea is to allow a margin of power over the requirements when working a full load, which the present engine does not give.

Annual Outing.—The first annual outing of the Electrical Company, Limited, took place at Hampton Court on Tuesday, the 7th inst. The employés, with their wives, met at 122, Charing Cross Road, from whence the party proceeded by coaches. After dinner some of the party went for a trip up the river in a steam launch.

Notting Hill Electric Lighting Company, Limited.—We learn that this company intends to apply to Parliament for power to extend the supply of current to the district of North Kensington. At a special meeting of the company, held on July 10th, a dividend was declared on the 6 per cent. preference shares for the six months ending June 30th.

Electric Lighting in Spain.—We learn from a Spanish source that a company has just been formed at Seville to establish a central electric lighting station in that town. The company, which is known as the Sociedad Sevillana de Electricidad, has a capital of £80,000, part of which has been subscribed in Germany.

Fareham and the Electric Lighting.—The Local Board have resolved to amend the resolution passed on June 14th "to purchase the business of the Electric Light Company for a sum of not more than £5,000," and have decided to substitute "by valuation" for the words "for a sum of not more than £5,000."

Cardiff Telephone Service.—The National Telephone Company propose laying the telephone wires underground, and the Corporation have resolved to charge them £1 per pipe per mile for this privilege. It is also the company's intention to have one large central exchange instead of two small ones as at present.

Radcliffe and Electric Lighting.—The Local Board are making inquiries as to the terms for providing plans and estimates for the electric lighting station, plant, and the necessary means and appliances and for all engineering assistance required up to and inclusive of the obtaining of a provisional order.

Warehouse Lighting at Dundee.—Messrs. Clunas and Allison have just had the electric light fitted upon the exterior of "The Central" Warehouse, Reform Street, Dundee. This installation consists of six arc lamps, each of 2,000 candle-power. The current is supplied from the city mains. Last week the installation was submitted to a thorough test, and was found to work satisfactorily in every respect. The contract was carried out by Messrs. Lowdon Brothers.

Kendal and Electric Lighting.—The Windermere and District Electricity Supply Company intend applying for an electric lighting order. From a discussion which transpired at the last meeting of the Council, it would appear that the company will have to meet opposition at their hands.

Rashleigh Phipps & Co.—This firm have received instructions for the electric lighting of Limmer's Hotel, Conduit Street and George Street, W. Messrs. Phipps have also received the contract for lighting the Howard Hotel, Norfolk Street, Strand, with 450 lights of 16 C.P.

Darlington and Electric Lighting.—The necessity has arisen for some extension of the gas works on account of the increased consumption. It has been proposed by a member of the council, that instead of spending money on extension, electric lighting be introduced.

Dundee Lighting.—In the estimates for the lighting department of the Police Commission is an item of £200 for "High Street Electric Lighting." The total expenses of the year (complete lighting of the town and additional lamps fixed during the period) were £7,068.

Montrose and Electric Lighting.—The Scottish House-to-House Electric Lighting Company are desirous of lighting the town by electricity, but the Police Commission contemplate applying for a provisional order empowering them to carry out the work themselves.

Bowness and Electric Lighting.—The Windermere and District Electricity Supply Company intend applying for a Provisional Order, but the Local Board mean to seriously discuss the question before they consent to the application being made.

Bromsgrove and Electric Lighting.—The firm of Hemming & Co. (Birmingham), asked the Local Board to allow them to lay down electric lighting plant for the district, but the matter is to be carefully considered before any decision is arrived at.

Reading Company and the Council.—Reading Electric Supply Company, Limited, recently applied to the Town Council for sanction to a proposal to lay a railway across Vastern Road. The Council have refused the application.

Chapel Lighting.—Trinity Road (Halifax) Baptist Chapel is to be lighted by electricity. Messrs. W. Emmott & Co. are the contractors. There will be about 100 incandescent lamps suspended from the ceiling.

Newmarket and the Electric Light.—The local Electric Lighting Company have applied to the Board of Trade for an extension of time for payment of the required deposit.

Agency.—Messrs. W. F. Dennis & Co., of Billiter Street, E.C., have been appointed sole agents in Great Britain and Ireland for the Antwerp Telephone and Electrical Works.

CONTRACTS OPEN.

Edgbaston, Birmingham.—September 1st. Tenders are invited for the electric lighting of the glasshouses, &c., at the Botanical Gardens, Edgbaston. Particulars may be obtained from the engineers, Messrs. Henry Lea and Thornbery, 38, Bennett's Hill, Birmingham.

Tenders Invited—France.—August 12th. The Prefecture of the Seine, in Paris, is inviting tenders for the carrying out of an installation of electric lighting in the School in the Rue de Reuilly. The contract calls for the supply of dynamo, motors, accumulators, &c.

CITY NOTES.

Crompton & Co., Limited.

The sixth annual general meeting of Crompton & Co., Limited, was held at the Cannon Street Hotel on Monday, Viscount Emlyn (the chairman of the company) in the chair. About 20 shareholders attended, but none of them took any part in discussing the report and accounts.

The Chairman, in moving the adoption of the report and accounts, said there was a slight reduction of the gross profits; but there were, notwithstanding that, several matters on which he thought he might very fairly congratulate the shareholders. First of all the amount of business done exceeded that of the previous year by just £22,000, and by careful economy and watchfulness, they had been able to reduce the item of "Trading and office expenses, salaries, agencies, &c.," in the profit and loss account by £3,000. The accounts before the meeting showed a diminution of £4,000, the difference being occasioned by the fact that this year the "interest on bankers' loans" had been taken from the profit and loss account, and placed in revenue. In the opinion of the directors that was a more correct way of dividing the expenses, but the net result was practically a saving of £3,000 in the results of the year, and the directors had further economies in view, which they had in effect begun, by rearranging the departments of the company, and it was hoped that a better result would be shown by the end of next year. The item "depreciation of plant" was increased by £900, chiefly caused by the items dealt with under that head last year; but that did not apply to the whole, for some of it was due to the desire of the directors to err on the side of over caution. With regard to the subsidiary companies they would see that there was an apparent further increase, but this was mainly due to the fact that an item in the Chelmsford Company had been transferred from "trade debtors," and secondly, to the company having had to take a considerable amount of debentures from the Australian Company instead of, for the present, receiving cash. This need not be taken as an investment, as it was only practically taking debentures until the company was in a position to pay cash. Both these items had been transferred from "trade debtors account," and stood now as an investment, subject to what he had just said. The stock in trade showed an apparent decrease on last year, but this was in consequence of separating the item "work in progress and contracts" from "stock in trade." Practically, there was hardly any alteration. There was another matter about which they would expect him to say something, and that was the depreciation of assets. Now, as was explained to the meeting in January last in reply to some questions addressed to him, he then explained that no contracts had been taken for some three or four years under which the company was bound to accept payment in shares or securities instead of cash for work done. But, during the last year, some of the securities taken in former years in payment had, in the opinion of the directors, depreciated, and they had thought that they ought not to stand on the books at the amounts they had previously stood at. They, therefore, proposed that an amount of £20,000 should be written off, and to enable this to be done they had obtained the assent of the two managing directors, Messrs. Crompton and Albright, to relinquish an equal amount of ordinary shares. Taking advantage of that, the directors had carefully examined the whole of the assets. They had tried to clear their books of anything that might appear doubtful in any way, and if they had erred, they had erred in writing this account down very severely—to the extent of £20,000. He should explain—though, perhaps, he did not know that it was necessary—that, of course, as far as the assets of these investments were concerned, it was a mere book-keeping account being written down. They were all available for what they were worth, and, if they improved in value, they would still do so for the shareholders. At the conclusion of the meeting, it was proposed to make it special for the purpose of passing the resolution to carry it out, and to hold another meeting in a month for the same purpose; and, after that, to make an application to the Court of Chancery to sanction it. He was sure a debt of gratitude was owed to the managing directors for assisting them in dealing with the matter. Since the last meeting the manager at Chelmsford had resigned, having accepted another appointment. Mr. Brunton had been appointed, and the results during the last few months fully justified the view taken as to his work there. Last year they mentioned that, as far as future prospects were concerned, they thought they might say that the Australian Company had very good prospects. The orders from that company at present amounted to a very considerable sum, and the latest information stated that the contracts in hand, which were practically secured at that date, amounted to about £40,000. That would give some idea of the development of the Australian Company. Now, in a great deal of the work the company did they had to compete with other companies very closely, but there were one or two departments in which the Crompton Company had specialities. The arc lamp department, he was glad to say, was quite coming up to what was expected of it. The cooking and domestic appliances department was going on very well, and they believed it to be a very valuable property. There was no doubt that as these things became better known, and as they were able to reduce the cost of production, it would be appreciated by the public. The Vestry of St. Pancras had issued a circular recommending the company's cooking appliances. He should have liked to have told them they were going to pay the full dividend, and, as a matter of fact, the net profits would have allowed a larger dividend than they proposed. They could have had recourse to the reserve fund, and there was without that a balance available; but the directors thought that the best interests of the shareholders would be consulted by paying a moderate dividend. They proposed to increase the contingencies fund by £1,000, and the balance of net profits carried forward would be something over £1,000. At the January meeting it was explained why an interim dividend had not been declared, the indebtedness to the bankers having become so large, that it was thought not advisable, or at any rate until the proposed new issue of debentures had been made. The directors recommended the shareholders to take up the debentures to place the company on a thoroughly sound footing, for want of capital prevented buying in the cheapest market, and getting reductions in prices.

Mr. R. E. B. Crompton, in seconding the motion, said that they had no doubt in the past year been adversely affected by the competition of new firms manufacturing electrical appliances without a full knowledge of what they were doing, which had had the effect of reducing market prices to such an extent that it had been a hard matter to fill order sheets with orders at profitable prices. But erroneous estimating was working its own end, and weaker firms

would be weeded out, as they found that such contracts could not be carried out at a profit. As regarded the change in the management, he could only confirm what the chairman had said. Mr. Brunton was the best man he could possibly have picked if he had had every man in England to choose from. In his opinion the company was now in a better position than ever it was before for meeting the severe competition of the present time. He did not believe that at any time their manufacturing department had been in better order. With regard to prices, he hoped that the tendency would be rather to increase than to diminish them, but, if the low prices of the last year held good for the present, he felt convinced that the Crompton Company were in as good, if not a better position, for meeting extremely low rates than any other firm in England, and to take prices which would yield them a profit, whereas they would not yield a profit to their competitors.

The report and accounts were adopted without discussion.

On the motion of the CHAIRMAN, seconded by Mr. J. F. ALBRIGHT, a dividend at the rate of 3s. per share was declared on the preference shares.

Viscount Emlyn was re-elected chairman, as were also Messrs. J. H. Duncan & Co., auditors of the company.

The meeting was then made special, and the following resolution was adopted without dissent:—"That the capital of the company be reduced from £300,000 to £280,000 by cancelling paid up capital which has been lost, or is unrepresented by available assets, to the extent of £20,000, by cancelling 4,000 ordinary fully paid up shares of the company, numbered 2,785 to 6,784, inclusive, which have been issued."

The usual complimentary resolutions terminated the proceedings.

Liverpool Overhead Railway Company.

THE twelfth ordinary half-yearly general meeting of the shareholders of the Liverpool Overhead Railway Company was held on Tuesday at the Law Association Rooms, Cook Street, Liverpool.

Sir WILLIAM FORWOOD, chairman of the company, presided, and in moving the adoption of the report and statements of accounts, expressed his pleasure that they were of a very satisfactory and encouraging character. During the half-year the traffic had increased to an extent which ought to give them great encouragement for the future. Unfortunately, as their undertaking was a comparatively new one, it was difficult to get figures for purposes of comparison. If they compared the traffic for the past half-year with that of the preceding half-year, they compared the summer with the winter traffic; and, again, if they compared it with the period when the line was first opened, they had only a broken half-year, as the undertaking had only been opened four months prior to the second half of last year. The figures given in the report showed that during the past half-year they had carried 2,861,000 passengers, as against 2,475,000 during the preceding half-year, being an increase of nearly 390,000. It was impossible to compare them with the previous broken half-year, but he thought these figures would be sufficient to give an indication of the increase of the traffic. During last half-year they had carried 15,300 passengers per day, as against 11,810 per day during the corresponding portion of last year. These figures would give them some idea of the improvement that had taken place. Then, again, as regards the receipts, taking the traffic from April 30th to June 30th last year as compared with the same period this year—and April 30th last was the date on which they opened the Seaforth Sands Station, so that they had had the advantage of that traffic this year—they found that during the nine weeks of last year the receipts were £5,890, whereas during the same nine weeks this year they were £8,045, being an increase of £2,155, or equal to 30 per cent., which was a very gratifying increase. Then since the close of the half-year with which they were dealing in the report, the increase had been kept up. During the six weeks that had elapsed since June 30th, as compared with the same period last year, the receipts had run up £1,100. He thought those figures would be very satisfactory. They opened Seaforth Sands Station on April 30th, and he was glad to say the traffic had been everything they expected it to be. It had been a valuable feeder to the line. They had recently opened two new stations—one at the Nelson Dock and the other at the Huskisson Dock, the latter being a removal from the Sandon graving dock; and so far as they had experienced, the traffic from them would also be valuable feeders. A third station would shortly be opened at the Langton Dock, and when this was completed they might say that no one could complain of having far to walk from one station to another. He had just been informed that the Langton Dock Station would be opened on the following day. They had also made arrangements with the Liverpool Tramways and Omnibus Company whereby they would secure the co-operation of that powerful body in developing their traffic in the Seaforth district, and they looked upon that as certain to bring them a considerable increase of traffic. Turning to the revenue account, they had received under that head for the past half-year £20,011, being an increase of £1,669 upon the previous half-year. These figures might possibly be disappointing, seeing the large increase that had taken place in the number of passengers carried; but when they considered that the increase was largely made up of the cheap workmen's tickets issued in the morning, they would understand why the revenue was not proportionately greater. They were well pleased with the early morning service, and felt they were doing good service to the working men of the city and district. They had spent during the half-year £14,947, being an increase of £1,215 upon the previous half-year; but the increase was made up of two or three items, including £425 spent upon the carriages. They felt that they required a better system of ventilation of the carriages, and this had been done at the cost indicated. They had also spent £878 in traffic expenses, which was largely made up of the cost of the new stations they had opened, and also the cost of running 22,000 extra miles in the past half-year, as compared with the preceding half-year. Their rates, taxes, &c., also showed an increase of £255, and the law charges were somewhat heavier than in the half-year before. On the other hand they had effected a considerable economy in taking the generating station into their own hands. The contract terminated on January 1st this year, and if they had been working under it, they would have had to pay £4,089 for locomotive power, but this had only cost them £3,179, a saving of £910 during the six months, which he thought the shareholders would call very satisfactory. The total receipts for the half-year were £20,044, and the working expenses £14,947, which left £5,097 to be dealt with. They had paid the interest on debentures and calls paid in advance, amounting to £2,639, which left £2,457. To that had to be added the balance brought forward from last year, amounting to £2,598; leaving available for dividend £5,056. With reference to the southern extension, the board were very much impressed with the desirability of carrying that out at the earliest moment possible, but they wished to see the present system developed further before carrying out the work, and they would come before the shareholders to obtain their sanction before undertaking it. They were quite sure that there was a large field of traffic waiting them at the south end, from which they would derive as much benefit as they had already derived from the northern extension. He was sorry to say their claim upon the Mersey Dock Board had not yet been adjusted, but he hoped they would soon have it satisfactorily settled. He was glad to say that every servant in their employ took a great interest in the undertaking, and he was sure the action of the board in erecting an institute at Seaforth Sands Station for their men would meet with the approval of the shareholders. They had also established a tontine society and an athletic society, and he had no doubt all these things would tend to that *esprit de corps* which was necessary to the satisfactory working of such an undertaking. He was glad to say that the line was gaining in popularity.

Mr. R. HOBSON seconded, and the motion was carried.

On the motion of the CHAIRMAN, seconded by Mr. HOBSON, a dividend at the rate of 5 per cent. per annum on the preference shares, and 1 per cent. on the ordinary shares, was declared for the past half-year, leaving £1,010 to be carried forward to next account.

A vote of thanks to the chairman closed the proceedings.

Birmingham Central Tramways Company, Limited.

THE annual meeting of this company was held on Wednesday at Birmingham, Mr. Joseph Ebbsmith presiding. The directors reported a profit for the year of £52,000, and recommended the dividend upon the 5 per cent. guaranteed shares and 2½ per cent. upon the ordinary. The chairman, speaking of the proposed reduction of capital, said the board believed if they reduced the £10 shares by half, profits would be sufficient to put a reserve against depreciation, a solid reserve to meet the period of distribution to pay regular dividends of 5 per cent., and provide £5 per share at the end of the term. The report was adopted.

The Charing Cross and Strand Electricity Supply Corporation, Limited.—The directors of the Charing Cross and Strand Electricity Supply Corporation, Limited, have declared an interim dividend for the half-year ended June 30th, 1894, at the rate of £4 per cent. per annum on the ordinary share capital of the Corporation (£150,000), and carried forward £1,335 2s. 7d., after payment of £5 per cent. per annum on debentures. The interim dividend will be paid on August 15th inst.

W. T. Henley's Telegraph Works Company, Limited.—An issue of £50,000 4½ per cent. mortgage debenture stock of this company is offered for subscription at par. The capital thus raised will be used to pay off existing debentures carrying 4½, 5, and 6 per cent., and for extending the business of the company.

Stock Exchange Settlements.—Applications have been made to the Stock Exchange Committee (1) to appoint a special settling day in, and to grant a quotation to, Metropolitan Electric Supply Company, Limited—£150,000 4½ per cent. first mortgage debenture stock.

Brockie-Pell Electric Lighting Company.—Subscriptions are being privately invited to the shares of this company; capital, £80,000. The company is to pay the vendor £55,000 for his patents, and a royalty of 5s. per lamp.

Cuba Submarine Telegraph Company.—For the half-year ended June, the directors propose a dividend at the rate of 8 per cent. per annum.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 12th, 1894, amounted to £897; week ending August 13th, 1893, £829; increase, £68; total receipts for half-year, 1894, £5,203; corresponding period, 1893, £5,066; increase, £137.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 10th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,219.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, August 8th.	Closing Quotation, August 15th.	Business done during week ended August 15th, 1894. Highest.	Lowest.
184,500*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	101 —104	101 —104	...	...
1,134,640*l*	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	37 — 40 xd	38 — 41	40½	40
2,932,680*l*	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	70 — 72 xd	74 — 76	74⅜	71⅛
2,932,680*l*	Do. do. Defd.	Stock	...	...	...	6¼ — 6⅜	6½ — 7	6⅝	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½ % §	6½ % §	12¼ — 12⅜	12½ — 13	13	12⅛
18,700*l*	Do. do. 5 % Bonds	100	...	...	...	... — ... xd	... — ...	...	...
75,000*l*	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10% ‖ §	... §	1 — 2	1 — 2	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	139 —143	139 —143	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½ % §	2 % §	2 % §	¼ — ¼	¼ — ¼	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½ — 13½	12½ — 13½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19½ — 20½	19½ — 20½	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½ %	4 %	4 %	4 — 4½	4 — 4½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¼ — 9⅜	9¼ — 9⅜	...	...
30,000*l*	Do. do. 4½ % Debs. of £50, Nos. 1 to 1,600	...	...	...	...	103 —106%	103 —106%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½ % §	3½ % §	...	8 — 9 xd	8 — 9	8⅞	8⅜
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼ % §	6¼ % §	...	15½ — 15⅝	15⅝ — 15⅞	15⅞	15⅝
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	16¼ — 16⅜ xd	16¼ — 16⅜	16⅜	16⅜
105,900*l*	Do. 5 % Debs., repay. August, 1899	100	...	...	...	105 —109 xd	105 —109	...	...
1,294,100*l*	Do. 4 % Mort. Deb.	Stock	...	...	...	116 —119	116 —119	117⅛	116⅜
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅝ — 15⅞	15⅝ — 15⅞	15⅞	15⅝
62,700*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
222,800*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	...	...	...	114 —117 xd	114 —117	...	...
95,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	104	...
129,100*l*	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	103 —106 xd	103 —106	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¼ % §	4¾ % §	4⅝ % §	8⅜ — 8⅝	8½ — 8⅝ xd	8⅞	8 1/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅝ — 15⅞	15½ — 15¾ xd	15⅞	15¾
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅝ % §	8⅝ % §	8⅝ %	20 — 20½	20 — 21	20¼	20½
200,000*l*	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	44 — 46	45 — 47	46	45½
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	...	...	...	108 —111	108 —111	110¼	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	⅜ — 1½	½ — 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4⅜ — 5	4⅝ — 5⅛	5	4 13/16
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14 — 15	14 — 15	14¼	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	13⅜ — 14⅛	13½ — 14⅜	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅜ — 5⅝	5½ — 5⅞	5⅝	5½
925,017*l*	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	109 —112	109 —112	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	⅛ — ⅜	⅛ — ⅜	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	3 — 5	3 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	108 —113	108 —113	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 % Debs.	Stock	...	...	...	85 — 95	85 — 95	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900*l*	Do. do. do. 5 % Debs.	100	...	...	...	102 —105	102 —105	102½	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2½ — 3	2½ — 3	...	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	96 —101	96 —101	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½ %	5 %	6¾ — 7⅛	6¾ — 7⅛	7 3/16	7
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	5¾ — 6⅛	5¾ — 6⅛	...	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	1¾ — 2⅛	1¾ — 2⅛	...	...
178,200*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	105 —108 xd	105 —108	...	...
222,700*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	105 —108 xd	105 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1 — 1⅛	1 — 1⅛	1⅛	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10 — 10⅜	10¼ — 10⅜	10⅜	10⅜
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	...	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	107 —110	107 —110	108½	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	115 —120	115 —120	...	...
169,000*l*	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½ %	4½ — 5½	4½ — 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	12½ — 13½	12½ — 13½	13½	13½
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14 — 14½	14 — 14½	14½	14⅜
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	128 —131	128 —131	130½	...
45,000	†Liverpool Electric Supply, £4 10s. paid	5	4½%	5 %	5 %	6⅝ — 6½	6½ — 6⅝	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½ %	8¼ — 8⅜	8¼ — 8⅜	8⅝	...
100,000*l*	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	... — ...	... — ...	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½ — 5½	4½ — 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	7 — 7½ xd	7 — 7½	7⅝	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½ — 9 xd	8½ — 9	8 9/16	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	6 — 6½ xd	6 — 6½	6 5/16	6 3/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, August 8th.	Closing Quotation, August 15th.	Business done during week ended August 15th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅜ — 3	2⅜ — 3	2 13/16	2⅜
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2¼ — 2½	2¼ — 2½	...	...
125,000£	Do. do. 4½ % Deb.	Stock	...	...	...	110 —113	110 —113	...	...
630,000£	City and South London Railway	Stock	...	⅝%	⅝%	36 — 38	36 — 38	37¾	36½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	2 — 2½	2 — 2½xd	...	...
50,000£	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	½ — ¾	½ — ¾	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 1⅝	1½ — 1⅝	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — ⅜	¼ — ⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1 — 1¼	1 — 1¼	...	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	¾ — 1	¾ — 1	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	7 — 8	7 — 8	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23¾	23⅝
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	103 —105	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8 3/16 — 8 5/16	8 1/16 — 8 5/16xd	...	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12⅞ — 13½	12¾ — 13 xd	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	40 — 42 xd	40 — 42	41½	40½
150,000£	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	102—105	102 —105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2 — 2¼	2 — 2¼	2	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8% §.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅜.

Electric Construction Corporation, 6 % Debentures, 87—92.

Electric and General Investment, shares of £5 (£1 paid), 1⅜—2¼.

Electricity Supply Corporation, Ordinary of £5, 5—5¼.

House-to-House Company (£5 paid), 1—1½.

Do. do. 7 % Preference, of £5, 5¼—5½.

Do. do. 6 % Debentures of £100, 101—103.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.

Liverpool Electric Supply, £5 (fully paid), 6½—6⅝.

Do. do. £3 10s. paid, 4½—4⅝.

London Electric Supply Corporation, £5 Ordinary, ⅞—1¼.

Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PHOTOMETRIC STANDARDS.

We have already had occasion to point out some objections to the use of the bolometer for the comparison of the intensities of various sources of light, the chief factor of complaint being uncertainty as to the thing which the bolometer actually absorbs at its blackened surface; but as there are similar defects in all present systems of measurement of radiant energy, we are bound to accept the results of bolometric tests with a fair amount of faith, reserving our opinion as to their actual meaning until further experiments have decided their value. The July number of the *Physical Review* gives an account of "A bolometric study of light standards," by Messrs. Clayton, H. Sharp, and W. R. Turnbull, of the Cornell University. Their bolometer strip was rolled out of a piece of Swedish iron to a thickness of 0·045 mm., its width being 1·5 mm. It was then placed in dilute sulphuric acid in which potassic bichromate had been dissolved, and a current was passed through it in such a way as to dissolve the iron. The potassic bichromate was introduced into the solution to dispose of the hydrogen bubbles which would otherwise have clung to the metallic surface, and which would have caused it to dissolve unevenly. In this way a strip was obtained which was about 0·025 mm. in thickness and still moderately strong.

Curves are given recording the bolometric readings with time, and they thus graphically represent the fluctuations of the various light standards. The English candle gives a decidedly wavy curve, denoting that the burning is correspondingly erratic; the German candle is scarcely an improvement. The Carcel lamp stands the test of time but little better than the best of standard candles. It has disadvantages entailed by the use of a light-absorbing chimney and a rapidly charring wick; and there is much doubt as to the accuracy with which it can be reproduced. The steadying effect of a chimney is very manifest from the curves. We cannot help thinking that a lamp with a chimney is the right thing if only the absorbtive and radiating effects could be eliminated. Although the Carcel lamp furnishes a very steady source of light, it is known to show slow changes in the amount of light emitted, rising to a maximum as the lamp and oil become heated, and then falling off with the charring of the wick. If a perfect chimney could be combined with a perfect candle, it appears to us that a happy compromise might be come to.

The authors point out that the Methven standard is faulty in that it requires a chimney, employs as an illuminant an indeterminate mixture of gases, and is affected also by variations in the pressure of the gas and by draughts of air in the room. The Vernon-Harcourt pentane burner, and the Hefner-Alteneck amyl-acetate lamp, while avoiding this difficulty, run into others perhaps equally serious. The open flame of the latter is not only of a decidedly reddish hue, but is also extremely sensitive to draughts and vibrations of the air. On this account it is only with the greatest care that the height of the flame can be adjusted to the prescribed limit.

THE OBACH DRY CELLS.

In the report which Prof. Jamieson has recently made on these cells, a number of E.C.C. cells were taken as a basis of comparison, the dimensions in the two cases being the same, or as nearly as possible the same.

Tests were taken in order to determine:—

1. *Potential Current.*—The variation of the potential difference at the terminals of each cell due to the variation of the current strength in its external circuit.

2. *Potential Time.* — Fall of potential while on closed circuit and maintaining approximately the same current throughout the whole test.

3. Total output in ampère-hours, discharging through a constant resistance until practically exhausted.

Two galvanometers were used, one of very high resistance as a voltmeter, and the other of very low resistance as an ammeter.

The high resistance astatic mirror galvanometer of 26,000 ohms (which was used as the voltmeter) had in circuit with it a resistance of 100,000 ohms, so that the total resistance was about 126,000 ohms. It was so controlled that a new Latimer Clark's standard cell of 1·454 volts at 15° C. produced a deflection of 300 scale divisions. Consequently, one scale division $= \frac{1·454}{300}$ or ·0048 volt.

The low resistance mirror galvanometer was under strong magnetic control and shunted by a short thick copper wire. It was then carefully calibrated for milliampères by the College Kelvin balance.

First Series of Tests of the E.C.C. and Obach Dry Cells.

Table of Weights and Dimensions.

	Weight.	Dimensions.
E.C.C. No. 2	2 lbs. 2 ozs.	16·5 c/m × 6·5 c/m diam.
Obach B.	2 lbs. 10 ozs.	15·6 c/m × 6·5 c/m diam.

Test 1.—Potential Current.

The two cells first had their E.M.F. measured. Then a current of a certain value was obtained from them alternately for a period of four minutes. At the end of that time the potential difference and current (which latter never fell much) were simultaneously noted.

The external variable resistances were then reduced, so that the current was increased by an equal amount each time, until it had risen from ·024 ampère at the beginning, to ·384 at the end. Sixteen pairs of readings were thus obtained.

The following is a table of the results :—

Table I.

Current in ampères.	Obach B. P.D. in volts.	E.C.C. P.D. in volts.	Current in ampères.	Obach B. P.D. in volts.	E.C.C. P.D. in volts.
0·000	1·512	1·488	0·192	1·388	1·296
0·024	1·488	1·440	0·216	1·388	1·270
0·048	1·478	1·425	0·264	1·388	1·248
0·072	1·440	1·388	0·288	1·388	1·248
0·096	1·416	1·344	0·312	1·320	1·224
0·120	1·392	1·344	0·336	1·320	1·176
0·144	1·392	1·320	0·360	1·320	1·176
0·168	1·388	1·296	0·384	1·286	1·128

Test 2.—Potential Time.

The test was continued over three days, of seven, six, and four and a half hours respectively.

The current through each circuit was kept at a constant value each day, viz. : 0·2 ampère on the first, and 0·3 ampère for the second and the third days.

The potential difference was noted every alternate five minutes.

A few of the results are given in Table II.

Test 3.—Total Output.

This test was made to determine the total number of ampère-hours from the above cells. They were connected with voltameters, and allowed to work continuously from Friday, February 16th, at 4 p.m., until Wednesday evening, February 20th, at 8 p.m., when the test was unfortunately stopped by a mistake on the part of the evening students. By this time the voltages had fallen to 0·68 volt for the Obach, and 0·5 volt for the E.C.C. The duration of this test was approximately 124 hours. The current was kept as nearly as possible constant at 100 milliampères. Calculating from these figures the ampère-hours should have been 12·4.

Table II.

	First day (A).		Second day (B).		Third day (C).	
Time in minutes.	Obach P.D. in volts.	E.C.C. P.D. in volts.	Obach P.D. in volts.	E.C.C. P.D. in volts.	Obach P.D. in volts.	E.C.C. P.D. in volts.
0	1·392	1·346	1·272	1·224	1·248	1·080
10	1·320	...	1·180	0·984	1·104	0·792
15	...	1·200	1·152	...	1·104	...
20	1·296	1·200	1·152	0·960	...	0·768
25	...	1·200	1·128	...	1·104	...
30	1·286	...	1·128	0·936	1·080	0·768
60	1·272	...	1·128	0·840	...	0·720
65	...	1·166	1·128	...	1·080	...
90	1·248	...	...	0·806	...	0·710
95	...	1·152	1·128	...	1·080	...
120	1·248	...	...	0·787	...	0·695
125	1·248	1·128	1·128	0·787	1·056	...
150	1·248	1·128	1·128	0·787	...	0·695
155	...	1·128	1·128	...	1·046	...
180	1·224	...	...	0·777	...	0·686
185	1·224	1·128	1·128	...	1·032	...
240	1·224	1·128	...	0·744	0·998	0·648
245	1·224	1·128	1·100	...	0·974	...
300	1·200	...	...	0·734		
305	1·200	1·056	1·052	...		
360	1·200	1·046	1·008	0·710		
365	1·200	1·046				
420	1·190	0·998				
425	1·190	0·998				

The real results were :—

Obach B. ... ... 12·65 ampère-hours.
E.C.C. No 2. ... ... 10·35 „ „

The following table shows the output of these cells during tests 1 and 2 with the initial and final potential difference.

Table III.

Test.	Obach B. P.D. in volts.		Both cells. Time in hours.	Current in ampères.	Ampère-hours.	E.C.C. No. 2. P.D. in volts.	
	Initial.	Final.				Initial.	Final.
Test 1.	1·512	1·286	2	various	·2016	1·488	1·128
Test 2.							
1st day	1·392	1·190	7	·2	1·40	1·346	0·998
2nd day	1·272	1·008	6	·3	1·80	1·224	0·710
3rd day	1·248	0·960	4½	·3	1·35	1·080	0·624

Total output for tests 1 and 2 = 4·7516 ampère-hours.

Adding this to the output through the voltameters, we obtain the total output in ampère-hours, leaving both cells with slightly more than half a volt.

Total Output.

Obach B. ... ... 17·4 ampère-hours.
E.C.C. No. 2 ... ... 15·1 „ „

Excess of Obach over E.C.C. 2·3 ampère-hours.

Second Series of Tests of E.C.C. and Obach Dry Cells.

A new pair of cells was used for this series of tests, namely, an Obach A. and an E.C.C. No. 1.

Table of Weights and Dimensions.

	Weight.	Dimensions.
Obach A.... ...	4 lbs. 6 ozs.	7½ inches × 3½ inches diameter.
E.C.C. No. 1 ...	3 lbs. 9 ozs.	7½ „ × 3½ „ „

The tests taken were as follows :—

1. Potential current.
2. Internal Resistance.
3. Total output in ampère hours and watt-hours.
4. Recuperativity.

4*a*. Potential time.

5. Behaviour as storage cells.

5*a*. Power time or out-put in watt-hours.

Test 1.—Potential Current.

The test was conducted as follows :—

(1.) The E.M.F. of each cell was taken.

(2.) Currents of certain values were obtained from each cell alternately for five minutes.

(3.) The potential difference and current at the end of each period of five minutes was noted.

(4.) At the end of each five minutes the current was stopped, and readings taken of E.M.F. every five seconds until it became steady. By plotting the curve backwards, the value of the E.M.F. at the end of the five minutes was ascertained.

Table IV. shows a few of the results :—

Table IV.

Current in ampères.	Obach A.			E.C.C. No. 1.		
	E.M.F. in volts.	P.D. in volts.	E.M.F. at end of each 5 mins.	E.M.F. in volts.	P.D. in volts.	E.M.F. at end of each 5 mins.
0·000	1·488	...	...	1·401	...	...
0·024	...	1·430	1·440	...	1·372	1·392
0·048	1·430	1·410	1·432	1·392	1·372	1·387
0·072	1·420	1·392	1·412	1·372	1·358	1·368
0·096	1·420	1·382	1·392	1·372	1·344	1·358
0·120	1·416	1·368	1·372	1·368	1·329	1·344
0·144	1·401	1·368	1·372	1·368	1·320	1·344
0·168	1·392	1·358	1·372	1·359	1·305	1·329
0·192	1·392	1·344	1·368	1·344	1·296	1·320
0·216	1·372	1·344	1·368	...	...	...

Test 2.—Internal Resistance as calculated from the results of Test 1, given in Table IV.

The potential difference at the end of each period of five minutes was deducted from the total E.M.F. at the end of each period. This gives the voltage absorbed inside the cell. Then this internal voltage or fall of potential inside the cell, divided by the current at the time, gives the apparent internal resistance of the cell.

The following table shows the results :—

Table V.

E.M.F. absorbed (volts).		Current (ampères). Obach and E.C.C.	Resistance of cell (ohms).	
Obach A.	E.C.C. 1.		Obach A.	E.C.C. 1.
·010	·020	·024	·416	·833
·020	·015	·048	·416	·312
·020	·010	·072	·281	·138
·010	·014	·096	·104	·145
·004	·015	·120	·033	·125
·004	·024	·144	·027	·166
·014	·024	·168	·083	·142
·024	·024	·192	·125	·125
·024	...	·216	·111	...

Test 3.—Total Output.

The cells used in the last test, viz. : an Obach A., and an E.C.C. No. 1 were connected up with a constant resistance of about 10 ohms. A reading of the E.M.F. was taken at the beginning. Then readings of current and potential difference were taken every 10 minutes, for two hours, and less frequently afterwards. Voltameters were also placed in circuit to find the total ampère hours.

The gain of the Obach's plate = 40·557 grammes.
" " E.C.C.'s " = 35·264 "

Weight of copper deposited in one hour by 1 ampère = 1·177 grammes, therefore the total number of ampère hours from :—

Obach A. ... ... = 34·4 ampère hours.
E.C.C. No. 1 ... ... = 29·9 " "

Table VI. shows a few of the results.

Table VI.

Time.	Obach A.			E.C.C. No. 1.		
	P.D. in volts.	Current in ampères.	Watts.	P.D. in volts.	Current in ampères.	Watts.
Minutes.						
0	1·488	·162	·241	1·464	·148	·216
10	1·440	·162	·233	1·416	·146	·206
20	1·440	·162	·233	1·372	·145	·199
30	1·416	·162	·229	1·372	·145	·199
60	1·416	·162	·229	1·348	·146	·199
90	1·416	·165	·233	1·348	·147	·200
120	1·416	·170	·234	1·344	·150	·202
Hours.						
4½	1·392	·172	·236	1·344	·152	·201
23½	1·296	·161	·206	1·195	·138	·164
47½	1·272	·157	·188	1·104	·127	·140
74	1 200	·156	·133	1·046	·124	·129
240	0 902	·122	·109	0·902	·110	·099
336	0·902	·114	·099	0·902	·108	·090
360	0·864	·112	·094	0·888	·106	·088

Table VII.—Showing E.M.F., P.D., Resistance and Output.

Cell.	E.M.F. in volts.	Potential difference in volts.		Resistance in ohms.		Output.	
		Initial.	Final.	Int.	Ext.	Ampère hours.	Watt hours.
				Approx.	Approx.		
Obach A. ...	1·488	1·440	0·864	·30	10	34·4	50·2
E.C.C. No. 1	1·464	1·372	0·888	·62	10	29·9	34·4

Test 4.—Recuperativity.

This test was carried out with the same cells as in the last test, viz., Obach A, and E.C.C. No. 1. They were short circuited for 120 hours so as to be practically exhausted.

The same galvanometer was employed as a voltmeter, and readings of the potential difference were taken every five minutes for an hour, and at longer intervals thereafter.

Table VIII. gives a few of the results :—*

Table VIII.

Time.	P.D. Obach A.	P.D. E.C.C. No. 1.	Time.	P.D. Obach A.	P.D. E.C.C. No. 1.
Minutes.	Volt.	Volt.	Minutes.	Volt.	Volt.
5	·192	—	50	·480	·864
10	·288	·576	55	·480	·864
15	·288	·672	60	·504	·864
20	·312	·720	65	·528	·880
25	·336	·768	85	·552	·912
30	·360	·816	125	·576	·912
			Hours.		
35	·384	·816	3	·624	·960
40	·432	·864	24	·782*	1·056*
45	·432	·864			

London, June 2nd, 1894.

Note of Messrs. Siemens Bros. & Co., Ltd.

* Referring to Professor Jamieson's Test 4 on recuperativity, and the corresponding curves on sheet V., it might seem at first glance that the recuperation of the "E.C.C." cell, shown in the above Table VIII. as 1·056 volt, was superior to that of the "Obach" cell, which reached a voltage of only ·782.

A closer investigation of this statement, although correct in itself, shows that the "Obach" cell had, when this test began, an internal resistance of only ·3 ohm, whereas that of the "E.C.C." had already attained more than double that amount, viz. :—·62 ohm. The output of current during the short-circuiting for 120 hours must therefore have been considerably greater for the "Obach" cell, by reason of its lower resistance, than in the "E.C.C." cell. In consequence of this, the test of recuperativity showed after ten minutes a voltage of ·288 for the "Obach," and ·576 for the "E.C.C.," resulting after 24 hours recuperation in a net increase of ·494 volt in favour of the "Obach," and ·480 volt in favour of the "E.C.C."

This is a result most favourable for the "Obach" cell, the more so when we consider that it was doubly as much exhausted, when the experiment began as its competing "E.C.C." cell. According to our own experiments, we are in a position to say that had a longer time been allowed for recovery, say some days, instead of one day only, our cell would invariably reach by recuperation a final E.M.F. of 1·2 to 1·3 volt. This maximum is more rapidly reached by the smaller than by the larger sizes, since it depends almost entirely on the rapidity of permeation of the depolariser by atmospheric oxygen.

Approved by Professor JAMIESON.

Test 4a.—Potential Time.

This is the same as Test 3. Both cells were coupled up through a constant resistance of five ohms, and the fall of voltage was noted for about an hour after the current started.

Table IX.

Time.	Obach A. (P.D.)	E.C.C. 1. (P.D.)	Time.	Obach A. (P.D.)	E.C.C. 1. (P.D.)
Minutes.	Volt.	Volt.	Minutes.	Volt.	Volt.
0	·888	1·094	30	·528	·624
5	·576	·648	35	·528	·624
10	·555	·648	40	·513	·614
15	·537	·648	45	·504	·600
20	·528	·633	50	·480	·600
25	·528	·624	55	·480	·600

Test 5.—Behaviour as Storage Cells.

The above cells were then short-circuited for a considerable time until the voltage had fallen to ·048 volt in the case of the Obach, and ·168 volt in the case of the E.C.C. They were then connected up in series and charged with a current of about two ampères from the storage cells in the laboratory. The current was kept on for seven hours, *i.e.*, until 14 ampère-hours had been given to them.

The E.M.Fs., when disconnected, were: Obach = 1·464 volt; and E.C.C. = 1·296 volt.

Test 5a.—Power Time.

The cells were then discharged through a constant resistance of five ohms, and the potential difference was observed every four minutes, as follows in Table X. The output in watts was derived from the product of the respective potential differences and their corresponding calculated currents. Or from $P.D^2 \div R$, where, R = 5 ohms external resistance.

Table X.

Time.	Obach. A.		E.C.C. No. 1.	
	P.D. in volts.	Corresponding current in ampères or P.D. ÷ R.	P.D. in volts.	Corresponding current in ampères or P.D. ÷ R.
Minutes.				
0	1·464	$\frac{1·464}{5}$ = ·292	1·293	$\frac{1·296}{5}$ = ·259
4	1·296	·259	·816	·163
8	1·272	·254	·768	·153
12	1·248	·249	·768	·153
16	1·248	·249	·768	·153
20	1·248	·249	·744	·148
24	1·248	·249	·744	·148
32	1·224	·244	·744	·148
40	1·200	·240	·744	·148
48	1·200	·240	·744	·148
60	1·186	·237	·744	·148
120	1·152	·230	·720	·144
Hours.				
23	·528	·105	·384	·076
27	·480	·096	·384	·076

Remarks.

Since these results have been obtained under exactly the same conditions for each cell, they form a very fair comparison of their general efficiency. They demonstrate in most cases the superiority of the Obach cell. This may be accounted for by its greater weight,* as it is 8 ozs. heavier than the E.C.C., but it is very little greater in bulk, and is quite as convenient to handle. When a large current is taken, a viscous sort of fluid begins to ooze from the Obach cell.† This may prove troublesome unless it is noticed. It may be said however, that with the moderate currents used in these tests no trouble was experienced until they were short-circuited, when, of course, the current was only limited by the internal resistance of the cell.

Bell Ringing Test.

In addition to these tests, two cells (one Obach and one E.C.C.) were tried in the following way, in order to ascertain which of them would ring an electric bell for the longer time.

The two cells were alternately placed in circuit with a trembling bell, for six minutes at a time, by means of a clock and mercury contacts. Each cell had alternately six minutes' work of ringing the bell, and six minutes' rest. After the clock had gone 1,552 hours 30 minutes, the E.C.C. cell failed to ring the bell. It had consequently done 776 hours 15 minutes' work with a corresponding time of rest. The Obach cell continued to ring the same bell, under identically the same conditions, for 1,700 hours 30 minutes from the commencement, or 850 hours 15 minutes' of work, with a corresponding number of hours' rest. Thus the Obach cell rang the bell for 74 hours longer than the E.C.C. cell.

* As regards the somewhat greater weight of our cell in comparison with the "E.C.C.," this is chiefly due to the use of thicker zinc for our cells. Professor Jamieson in his former report, called attention to the circumstance that the "E.C.C." zincs were too thin for practical purposes; the heavier zinc is therefore rather an advantage than otherwise. S. B. & Co.

† With our earlier make of these cells, which were the sort supplied to Professor Jamieson, a viscous liquid occasionally oozed from the cell; we have, however, since then entirely overcome this defect by some slight alterations in the construction of the cell. S. B. & Co.

NEW PATENTS—1894.

14,570. "An automatic electric contact." G. Hussey. Dated July 30th.

14,580. "Continuous electric brakes for railway trains." A. Young. Dated July 30th.

14,602. "Improvements in controlling apparatus for electro-motors." J. B. G. A. Canet and A. Hillairet. Dated July 30th. (*Complete*).

14,607. "Improvements in electric cable traction apparatus." R. Lamb. Dated July 30th.

14,614. "Improvements in electric-magnetic motors." A. H. Beard. Dated July 30th.

14,624. "Improvements connected with fuel economisers and similar apparatus, flues and chimneys." T. Wrigley. Dated July 31st.

14,634. "Galvanic battery." C. E. Buell. Dated July 31st. (*Complete*).

14,642. "Electrical battery." V. I. Feeny. (Communicated by F. Dubero and P. Mohrdieck, United States.) Dated July 31st. (*Complete.*)

14,651. "Improvements in electrical heating devices." G. C. Dymond. (Communicated by J. A. G. Trudeau, Canada.) Dated July 31st. (*Complete.*)

14,689. "Improvements in secondary batteries." F. Tallack, F. W. Tallack, and L. Hendle. Dated July 31st.

14,690. "Improvements in and relating to centrifugal governors." H. H. Lake. (Communicated by Cie de l'Industrie Electrique, Switzerland.) Dated July 31st.

14,691. "Improvements in governing devices for motors." H. H. Lake. (Communicated by Cie de l'Industrie Electrique, Switzerland.) Dated July 31st.

14,765. "Improvements in apparatus for electrically effecting the reproduction at a distance of graphic matter or designs written, printed, stencilled, photographed, or otherwise produced." R. Greville-Williams. Dated August 1st.

14,768. "Improvements in electric arc lamps." A. L. Shepard. Dated August 1st.

14,769. "Improvements in or relating to apparatus for the production of sulphuric acid by the aid of an electric current." R. W. Hill. Dated August 1st.

14,770. "New or improved automatic apparatus for use in and in connection with the production of sulphuric and other acids." R. W. Hill. Dated August 1st.

14,841. "An improved diaphragm for phonographs and similar sound-recording and sound-producing machines." W. E. Hunnex. Dated August 2nd.

14,847. "Improvements in the means for storing electric energy." J. E. Liardet. Dated August 2nd.

14,850. "Improvements in the manufacture and production of filaments or incandescing media for electric lamps." R. Langhans. Dated August 2nd.

14,858. "Improvements in the purification of saccharine juices by electrolysis." J. Y. Johnson. (Communicated by E. Javaux, C. F. Gallois, and F. Dupont, France.) Dated August 2nd.

14,859. "Improvements in or connected with means for the supply or distribution of electricity." W. G. Little and C. W. G. Little. Dated August 2nd.

14,890. "Smoke consumption: generated in double-firing tube cylinder or Lancashire boilers consuming smoke and effecting a saving of fuel in the amount of steam raised." G. Stirk. Dated August 3rd.

14,922. "Electrically worked apparatus for regulating signals." W. Fiedler. Dated August 3rd. (*Complete.*)

14,926. "Improvements in electric telegraph and signalling apparatus." F. T. Hollins. Dated August 3rd.

14,987. "Improvements in or relating to the separation of caustic alkalies from the liquors obtained by the electrolysis of alkaline salts." W. L. Wise. (Communicated by Solvay & Co., Belgium.) Dated August 4th.

14,988. "An electrolytic table." W. L. Wise. (Communicated by E. Solvay, Belgium.) Dated August 4th.

15,000. "An improved wind motor for driving electric machinery and other purposes." H. Soifranc. Dated August 4th.

15,004. "Improvements in telephonic installation." G. Ritter. Dated August 4th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

9,906. "Improvements in the manufacture of elements or electrodes for voltaic batteries and electrolytic decomposition cells." D. G. FitzGerald. Dated May 17th. Claim:—In the manufacture of elements or electrodes for voltaic batteries, and electrolytic decomposition cells, the production of dense, coherent, non-disintegrating masses mainly composed of an oxide of lead, or a mixture of oxides of lead, by treating such oxide, or mixture of oxides, with a solution of the hydrate or hydrates of one or both of the fixed alkalies and converting the caustic alkali into carbonated alkali by exposure to an atmosphere containing carbonic acid.

10,129. "Improved electrical conductor." H. Edmunds. Dated May 20th. Claims:—1. An electrical conductor for conveying current to objects moving in contact therewith, the said conductor being composed of wires or strips of copper or other conductive metal plaited, interlaced, or interwoven in the manner and for the purpose explained. 2. An electrical conductor for conveying current to objects moving in contact therewith, the said conductor being composed of wires or strips of copper or other conductive metal plaited, interlaced, or interwoven in the manner and for the purpose described and afterwards subjected to compression.

10,218. "Improvements in methods of regulating the distribution of electricity, and in converting its energy into that of light." R. Wood. Dated May 23rd. Consists in using balancing dynamotors for the purpose of driving series machines in the feeders, and in placing in the path of a current through a conducting gas a substance which will absorb the heat generated by the passage of the current through such a resistance and transform it into light. 1 claim.

10,298. "Improvements in dynamo-electric machines." W. B. Sayers. Dated May 24th. Has reference to a machine which can be used to run in either direction, either as a generator or as a motor, without the necessity of providing it for this purpose with two commutators as described in a former specification. 7 claims.

10,788. "Improvements in the arrangement of stations for the generation of electricity." The Hon. C. A. Parsons. Dated June 2nd. Consists in a new system of arranging the plant whereby it is divided into distinct and complete units, each unit comprising boiler, engine, dynamo, and other appliances required to produce electricity economically. Each boiler, engine, dynamo or other appliance of a unit is also complete in itself and is so arranged as to pipe and other connections that any constituent part, such as a boiler, engine, dynamo may be applied to work or operate with any suitable part of another unit. 6 claims.

11,184. "Improvements in apparatus for effecting electrical communication between a number of separate stations or apartments with a central station or apartment." Siemens Bros. & Co., Ltd. (Communicated from abroad by F. E. Morgan and H. E. Walter, of America.) Dated June 7th. When a call current is transmitted from any station a magnet is excited and attracts its armature which closes a local circuit whereby another magnet is excited, and its armature releases the clockwork that drives a radial arm. Or when the radial arm stops on zero the magnet first mentioned releases the catch holding the arm, which thereupon moves over the successive plates. As soon as its brush bears upon a plate belonging to the station whence the call came, the circuit is closed through a second magnet which attracts its armature and stops the farther movement of the radial arm. The distant station and the central station now remaining in electrical communication, messages can be sent from the one to the other by telegraph or telephone. 3 claims.

12,314. "Improvements in electrically illuminated signs." G. C. Fricker. Dated June 22nd. The inventor employs one or more arc lamps of any suitable make, but instead of using a single pair of carbon rods as is usually done, he employs two or more pairs of carbon rods, the upper ones being all connected rigidly together by a metallic bar attached to the lamp rod which is controlled by the feed mechanism, and all the lower carbons he connects together by a similar rigid bar in electrical contact with the other terminal or pole of the lamp. Each pair of carbon rods is separately encased or screened by a transparent medium which emits light of the desired colour when an arc is maintained between the carbon points contained within it. 2 claims.

12,702. "Improvements in electric cables." G. G. M. Hardingham. (A communication from abroad from the firm of Felten and Guilleaume, of Mülheim-on-the-Rhine.) Dated June 28th. A cable constructed according to this invention has a tubular conductor composed of a series of wires of special section arranged in a circle about a central air-space and twisted together so as to retain one another in position. Each wire is wedge, hook, or V-shaped in transverse section, or is otherwise formed to interlock with its neighbours. 3 claims.

12,786. "Improvements in self-regulating mechanisms for electric arc lamps." A. G. New and A. J. Mayne. Dated June 29th. Consists of a disc of metal which fits loosely over and round the tube carbon holder, and on which are pivotted two arms, the inner ends of which are shaped to grip the tube, and the outer ends of which are connected by means of two links to the tubular core. This disc with its arms being below the tubular core, is thus supported by the core (when drawn up into its solenoid) by means of the two links, but the weight of the disc makes the inner ends of the arms grip the tube carbon holder before it is itself raised. Below this disc is placed an adjustable stop which comes into contact with the inner ends of the pivotted arms when the disc falls to a normal position, *i.e.*, when no current flows through the solenoid. When these arms come into contact with the adjustable stop, and when the stop begins to take the weight of the disc and core the arms become lifted and thus release the tubular carbon holder, allowing the carbons to come together. 4 claims.

12,850. "A counter of electricity." F. A. Brocq. Dated June 30th. Relates to an instrument which registers the intensity of an electric current multiplied by the time during which it is maintained, this instrument being of cheap and simple construction, with its acting parts quite enclosed so that the register cannot be tampered with. 6 claims.

12,857. "Improvements in and connected with tanks for the electrical decomposition of chloride of sodium or potassium in solution." J. C. Richardson. Dated June 30th. The inventor arranges horizontally between the electrodes, a screen, preferably of slate or glass strips or other material uninfluenced by the action of the decomposition. These strips are supported on ledges in the tank, and may be placed so as to overlap one another, like the slats of a Venetian blind, with spaces, however, between them, so as not to obstruct the passage of the current between the electrodes. 1 claim.

13,064. "Improvements in devices for prevention of retardation in electric cables." S. P. Thompson. Dated July 4th. Relates to electric cables, as described in the number of the Review for September 15th, 1893. 19 claims.

13,218. "Improvements in plates or elements for secondary electric batteries." The Lithanode and General Electric Company, Limited, and J. T. Niblett. Dated July 6th. Around the edges of each plate, slab, or pellet of lithanode, grooves, recesses, or holes, are formed so that when the requisite number of such plates, slabs, or pellets, are placed together, and the metal of the container or support, which constitutes also the conductor, is cast therearound, the metal enters the grooves, recesses, or holes, and firmly binds the plates, slabs, or pellets, together. 4 claims.

13,274. "Improvements in the manufacture of plates for electric accumulators." C. Rousseau. Dated July 7th. The inventor first moulds lead plates with longitudinal ribs, and then produces by mechanical means transverse or oblique cuts or slits in the said ribs so as to form clean teeth or projections more or less sharp or rectangular, and the shape of which may vary according to requirements. The said teeth, or projections, are designed to be beaten down more or less over the paste or active material to confine it and retain it in contact with the lead plate or core. 1 claim.

13,340. "Improvements in and relating to electric furnaces." H. H. Lake. (Communicated from abroad by A. C. Girard, and E. A. G. Street, both of Paris.) Dated July 8th. Comprises an exterior casing, preferably metallic, which may or may not contain a suitable block of refractory, or other material, formed in one or more parts. The said block, when such is used, has formed in its interior a cavity which constitutes the heating chamber proper, and in which terminates a radial channel adapted to receive a carbon rod that forms one electrode of the arc. Another channel extends right through the block, and into this latter channel the bar, rod, or the like, to be subjected to the treatment is introduced. To this bar or rod is imparted, by rotating friction rollers or other means, a translatory motion, which causes it to traverse the heating chamber at a speed which is regulated in accordance with its mass and the temperature to which it is to be heated. The electrical circuit is completed through the moving bar or rod to be heated and the carbon electrode before mentioned. 10 claims.

13,469. "Improvements in and in connection with electrical railway signals." F. B. Aspinall. Dated July 11th. The signals are so arranged that the action is automatic; the train passing a signal station leaves the signals behind it blocked and they so remain until the train passes the next signal station; the previous block is then removed and the signals last reached are blocked in their turn. A train reaching a blocked section of the line is warned by an audible signal, and if the warning be neglected the steam is presently shut off automatically and the brakes are applied. The inventor provides by the side of the line of rail insulated bars so that instruments on the engine of a passing train may come into contact with these bars in succession.

23,902. "Improvements in and relating to electric motors." W. P. Hall. Dated December 12th. Is generally applicable to all devices to be moved, but is especially designed for railway signal arms or semaphores, railway gates, railway switches, &c., in which the arms, semaphores, gates, switches, &c., are to receive a definite movement upon the breaking or closing of a circuit, or upon the happening of some event, such as the approach or recedence of a train. It consists of means for utilising an ordinary rotary electromotor to cause these movements. 13 claims.